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DOE/EIS-0161

# Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling

## Volume I

United States Department of Energy
Office of Reconfiguration

February 1995

DOE/EIS 0161

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1000 Independence Avenue, SW
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Attention: Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling, Volume I.

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**Department of Energy**
Washington, DC 20585

February 28, 1995

Dear Interested Party:

The Draft Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling has been completed. A public comment period will extend through May 15, 1995.

Tritium, a radioactive gas used in all of the Nation's nuclear weapons, has a short half-life and must be replaced periodically in order for the weapon to operate as designed. Currently, the Nation has no tritium production capability.

The Tritium Supply and Recycling PEIS evaluates the alternatives for the siting, construction, and operation of tritium supply and recycling facilities at each of five candidate sites: the Idaho National Engineering Laboratory, the Nevada Test Site, the Oak Ridge Reservation, the Pantex Plant, and the Savannah River Site. Alternatives for new tritium supply and recycling facilities consist of four different tritium supply technologies; Heavy Water Reactor, Modular High Temperature Gas-Cooled Reactor, Advanced Light Water Reactor, and Accelerator Production of Tritium. The PEIS also evaluates the impacts of using a commercial light water reactor, either as a contingency in the event of a national emergency or if purchased by the Department and converted to defense purposes. Additionally, the PEIS includes an analysis of multi-purpose reactors which would produce tritium, dispose of plutonium and produce electricity.

All interested parties are invited to submit comments by regular mail, by calling the Tritium Supply and Recycling toll free number at 1-800-776-2765, or electronically via computer with a modem or through Internet. For information on mailing comments or sending them electronically, please call the toll free number. Public hearings on the Draft PEIS are scheduled to begin April 5 and run through April 20, 1995. Specific information regarding these hearings can also be obtained by calling the above toll free number.

Sincerely,

Stephen M. Sohinki
Director
Office of Reconfiguration

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## Volume I

United States Department of Energy
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# Acronyms, Abbreviations, and Conversion Charts

# Acronyms, Abbreviations, and Conversion Charts

## Acronyms and Abbreviations

| | |
|---|---|
| APT | Accelerator Production of Tritium |
| ALWR | Advanced Light Water Reactor |
| AQCR | Air Quality Control Region |
| CAA | *Clean Air Act* |
| CEQ | Council on Environmental Quality |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act* |
| CFR | Code of Federal Regulations |
| CWA | *Clean Water Act* |
| D&D | decontamination and decommissioning |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOI | Department of the Interior |
| DOT | Department of Transportation |
| DP | DOE Office of the Assistant Secretary for Defense Programs |
| EA | environmental assessment |
| EIS | environmental impact statement |
| EM | DOE Office of the Assistant Secretary for Environmental Management |
| EPA | Environmental Protection Agency |
| ES&H | environment, safety, and health |
| HAP | hazardous air pollutants |
| HE | high explosive(s) |
| HEPA | high efficiency particulate air |
| HEU | highly enriched uranium |
| HI | Hazard Index |
| HLW | high-level waste |
| HQ | Hazard Quotient |
| HWR | Heavy Water Reactor |
| INEL | Idaho National Engineering Laboratory |
| IP | implementation plan |
| $L_{eq}$ | equivalent sound level |
| LLW | low-level waste |
| MHTGR | Modular High Temperature Gas-Cooled Reactor |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | *National Environmental Policy Act* of 1969 |
| NESHAP | National Emissions Standards for Hazardous Air Pollutants |
| NOI | Notice of Intent |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| NRHP | National Register of Historic Places |
| NTS | Nevada Test Site |
| ORNL | Oak Ridge National Laboratory |
| ORR | Oak Ridge Reservation |
| OSHA | Occupational Safety and Health Administration |

| | |
|---|---|
| PEIS | programmatic environmental impact statement |
| $PM_{10}$ | particulate matter of aerodynamic diameter less than 10 micrometers |
| RCRA | *Resource Conservation and Recovery Act* |
| ROD | Record of Decision |
| ROI | region-of-influence |
| SAR | Safety Analysis Report |
| SARA | *Superfund Amendments and Reauthorization Act* |
| SDWA | *Safe Drinking Water Act* |
| SHPO | State Historic Preservation Officer |
| SRS | Savannah River Site |
| START | Strategic Arms Reduction Treaty |
| TOC | total organic compounds |
| TRU | transuranic |
| TSCA | *Toxic Substances Control Act* |
| TSP | total suspended particulates |
| TSS | tritium supply site |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| VOC | volatile organic compounds |
| VRM | Visual Resource Management |
| WIPP | Waste Isolation Pilot Plant |

## Chemicals and Units of Measure

| | |
|---|---|
| BGY | billion gallons per year |
| Ci | Curie |
| $CC1_4$ | carbon tetrachloride |
| CO | carbon monoxide |
| CFC | chlorofluorocarbons |
| dB | decibel |
| dBA | decibel A-weighted |
| DCE | 1, 2-dichlororethylene |
| F | Fahrenheit |
| $ft^2$ | square feet |
| $ft^3$ | cubic feet |
| $ft^3/s$ | cubic feet per second |
| g | gram |
| gal | gallon |
| GPD | gallons per day |
| gpm | gallons per minute |
| GPY | gallons per year |
| HCFC-22 | chlorodifluoromethane |
| HMX | cyclotetramethylenetetranitramine or 1, 3, 5, 7-tetranitro-1, 3, 5, 7-tetrazocine |
| hr | hour |
| kg | kilogram |
| kV | kilovolt |
| kVA | kilovolt-ampere |
| kW | kilowatt |
| kWh | kilowatt hour |
| lb | pound |
| lb/hr | pounds per hour |
| lb/yr | pounds per year |
| Li | lithium |
| mCi | millicurie (one-thousandth of a Curie) |
| mCi/ml | millicurie per milliliter |
| mg | milligram (one-thousandth of a gram) |
| mg/l | milligram per liter |
| MGD | million gallons per day |
| MGY | million gallons per year |
| mrem | millirem (one-thousandth of a rem) |
| MVA | megavolt-ampere |
| MW | megawatt |
| MWe | megawatt electric |
| MWh | megawatt hour |
| MWt | megawatt thermal |
| nCi | nanocurie (one-billionth of a Curie) |
| nCi/g | nanocuries per gram |
| $NO_2$ | nitrogen dioxide |

| | |
|---|---|
| $NO_X$ | nitrogen oxides |
| $O_3$ | ozone |
| Pb | lead |
| PCB | polychlorinated biphenyl |
| pCi | picocurie (one-trillionth of a Curie) |
| pCi/l | picocuries per liter |
| PETN | pentaerythritoltetranitrate |
| ppb | parts per billion |
| ppm | parts per million |
| Pu | plutonium |
| RDX | cyclotrimethylenetrinitramine |
| rem | roentgen equivalent man |
| $SO_2$ | sulfur dioxide |
| TATB | triaminotrinitrobenzene |
| TCA | 1, 1, 1-trichloroethane |
| TCE | trichloroethylene |
| TNT | trinitrotoluene |
| U | uranium |
| $yd^3$ | cubic yards |
| µCi | microcurie (one-millionth of a Curie) |
| µCi/g | microcuries per gram |
| µg | microgram (one-millionth of a gram) |
| µg/kg | micrograms per kilogram |
| µg/l | micrograms per liter |
| $\mu g/m^3$ | micrograms per cubic meter |
| µm | micron or micrometer (one-millionth of a meter) |

## Metric Conversion Chart

| To Convert Into Metric | | | To Convert Out of Metric | | |
|---|---|---|---|---|---|
| **If You Know** | **Multiply By** | **To Get** | **If You Know** | **Multiply By** | **To Get** |
| **Length** | | | | | |
| inches | 2.54 | centimeters | centimeters | 0.3937 | inches |
| feet | 30.48 | centimeters | centimeters | 0.0328 | feet |
| feet | 0.3048 | meters | meters | 3.281 | feet |
| yards | 0.9144 | meters | meters | 1.0936 | yards |
| miles | 1.60934 | kilometers | kilometers | 0.6214 | miles |
| **Area** | | | | | |
| sq. inches | 6.4516 | sq. centimeters | sq. centimeters | 0.155 | sq. inches |
| sq. feet | 0.092903 | sq. meters | sq. meters | 10.7639 | sq. feet |
| sq. yards | 0.8361 | sq. meters | sq. meters | 1.196 | sq. yards |
| acres | 0.40469 | hectares | hectares | 2.471 | acres |
| sq. miles | 2.58999 | sq. kilometers | sq. kilometers | 0.3861 | sq. miles |
| **Volume** | | | | | |
| fluid ounces | 29.574 | milliliters | milliliters | 0.0338 | fluid ounces |
| gallons | 3.7854 | liters | liters | 0.26417 | gallons |
| cubic feet | 0.028317 | cubic meters | cubic meters | 35.315 | cubic feet |
| cubic yards | 0.76455 | cubic meters | cubic meters | 1.308 | cubic yards |
| **Weight** | | | | | |
| ounces | 28.3495 | grams | grams | 0.03527 | ounces |
| pounds | 0.45385 | kilograms | kilograms | 2.2034 | pounds |
| short tons | 0.90718 | metric tons | metric tons | 1.1023 | short tons |
| **Temperature** | | | | | |
| Fahrenheit | Subtract 32 then multiply by 5/9ths | Celsius | Celsius | Multiply by 9/5ths, then add 32 | Fahrenheit |

## Metric Prefixes

| Prefix | Symbol | Multiplication Factor |
|---|---|---|
| exa- | E | 1 000 000 000 000 000 000 = $10^{18}$ |
| peta- | P | 1 000 000 000 000 000 = $10^{15}$ |
| tera- | T | 1 000 000 000 000 = $10^{12}$ |
| giga- | G | 1 000 000 000 = $10^{9}$ |
| mega- | M | 1 000 000 = $10^{6}$ |
| kilo- | k | 1 000 = $10^{3}$ |
| hecto- | h | 100 = $10^{2}$ |
| deka- | da | 10 = $10^{1}$ |
| deci- | d | 0.1 = $10^{-1}$ |
| centi- | c | 0.01 = $10^{-2}$ |
| milli- | m | 0.001 = $10^{-3}$ |
| micro- | µ | 0.000 001 = $10^{-6}$ |
| nano- | n | 0.000 000 001 = $10^{-9}$ |
| pico- | p | 0.000 000 000 001 = $10^{-12}$ |
| femto- | f | 0.000 000 000 000 001 = $10^{-15}$ |
| atto- | a | 0.000 000 000 000 000 001 = $10^{-18}$ |

# SUMMARY

# Summary

# SUMMARY

## INTRODUCTION

In January 1991, the Secretary of Energy announced that the Department of Energy (DOE) Office of the Assistant Secretary for Defense Programs (DP) would prepare a programmatic environmental impact statement (PEIS) examining alternatives for the reconfiguration of the Nation's Nuclear Weapons Complex (Complex). The framework for the Reconfiguration PEIS was described in the January 1991 *Nuclear Weapons Complex Reconfiguration Study*, a detailed examination of alternatives for the future Complex. Because of the significant changes in the world since January 1991, especially with regard to projected future requirements for the United States nuclear weapons stockpile, the framework described in the *Nuclear Weapons Reconfiguration Study* does not exist today. Therefore, the Department has separated the Reconfiguration PEIS into two PEISs: a Tritium Supply and Recycling PEIS; and a Stockpile Stewardship and Management PEIS. The Tritium Supply and Recycling Action is analyzed in this PEIS. Once formulated, the Stockpile Stewardship and Management Proposal will be analyzed in a PEIS in 1995.

Another issue which was once part of reconfiguration was the storage of all weapons-usable fissile materials, primarily highly enriched uranium and plutonium. In 1994, the DOE established a separate office within the Department to address not only the storage but the disposition of excess weapons-usable fissile material. As a result of this, a third PEIS, *The Storage and Disposition of Weapons-Usable Fissile Materials PEIS*, is being prepared to analyze alternatives for the long-term storage of all weapons-usable fissile materials, primarily highly enriched uranium and plutonium. This PEIS will also address the disposition of these materials declared surplus to national defense needs by the President.

## TRITIUM SUPPLY AND RECYCLING PROPOSAL

The DOE proposes to provide tritium supply and recycling facilities for the Complex. The Complex is a set of interrelated facilities supporting the research, development, design, manufacture, testing, and maintenance of the Nation's nuclear weapons and the subsequent dismantlement of retired weapons. The Complex currently consists of 11 sites located in ten states (figure S–1). Hanford and Idaho National Engineering Laboratory (INEL) are currently not part of the Complex. Tritium supply deals with the production of new tritium in either a reactor or an accelerator by irradiating target materials with neutrons and the subsequent extraction of the tritium in pure form for its use in nuclear weapons. Tritium recycling consists of recovering residual tritium from weapons components, purifying it, and refilling weapons components with both recovered and new tritium when it becomes available.

**Tritium Supply and Recycling Proposal:**

- **Provide the long-term, assured supply of tritium.**
- **Safely and reliably fulfill all future national defense requirements for tritium.**
- **Protect the health of workers, the general public, and the environment.**

There is now no capability to produce tritium within the Complex. Tritium, with a half-life of 12.3 years, is necessary for all weapons that remain in the stockpile. Thus, tritium must be replaced periodically as long as the Nation relies on a nuclear deterrent. Current projections require that a new source of tritium be available by 2009 and new tritium be available for stockpile use by 2011. This *Tritium Supply and Recycling Programmatic Environmental Impact Statement* evaluates the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at each of five candidate sites. Also analyzed is the use of an existing commer-

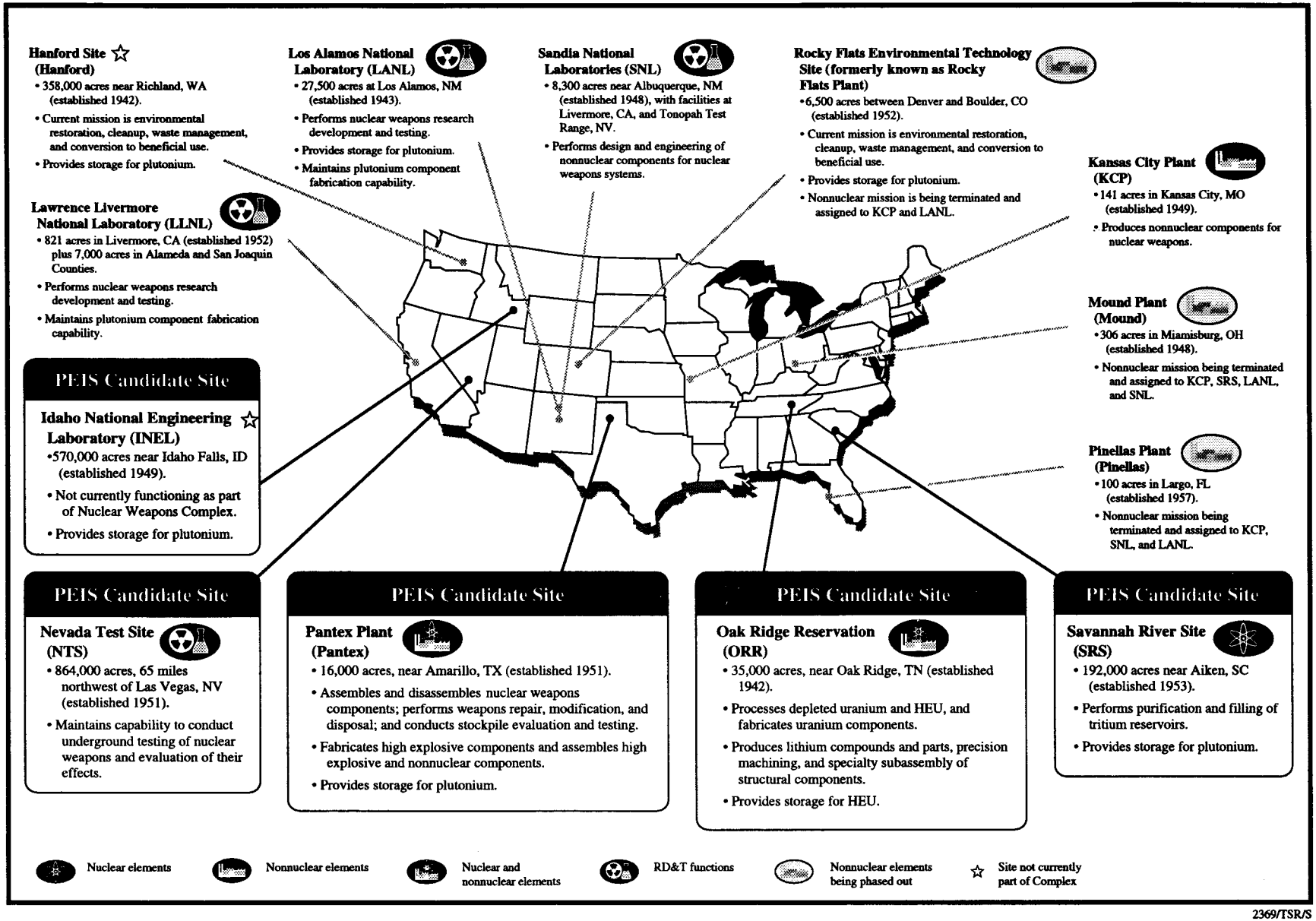


**FIGURE S–1.**—*Nuclear Weapons Complex Sites.*

cial light water reactor that would be purchased and converted for tritium production.

Additionally, this Tritium Supply and Recycling PEIS includes an assessment of the environmental and institutional impacts associated with using one or more commercial light water reactors for tritium production as a contingency in the event of a national emergency. This contingency option would permit the commercial reactor to continue normal electricity generation. Specific commercial reactors are not identified in this PEIS.

This PEIS also addresses the environmental impacts of an Advanced Light Water Reactor (ALWR) or modular gas-cooled reactor used as a multipurpose reactor. A multipurpose ("triple play") reactor is defined as one capable of producing tritium, "burning" plutonium, and generating revenues through the sale of electric power. The multipurpose ALWR would operate essentially the same as a uranium-fueled tritium production ALWR. Therefore, the environmental impacts from operation of a multipurpose ALWR would be expected to be unchanged from the tritium production ALWR. However, a plutonium pit disassembly/conversion/mixed-oxide fuel fabrication facility would be needed to provide the mixed-oxide fuel rods for the ALWR multipurpose reactor, and would be the major contributor to potential environmental impacts for this scenario. For a modular gas-cooled multipurpose reactor, twice as many reactor modules would be needed both to meet tritium requirements and to burn plutonium. A plutonium pit disassembly/conversion/fuel fabrication facility would also be needed. Thus, the potential environmental impacts for a multipurpose gas-cooled reactor are expected to be substantially greater than a uranium-fueled tritium production gas-cooled reactor.

Under No Action, DOE would not establish a new tritium supply capability. The current inventory of tritium would decay and DOE would not meet stockpile requirements of tritium. This alternative would be contrary to DOE's mission as specified by the *Atomic Energy Act* of 1954, as amended. Alternatives for new tritium supply and recycling facilities consist of four different tritium supply technologies and five locations as shown in figure S–2.

The Tritium Supply and Recycling Proposal will proceed in three phases. The first phase involves preparing information to support programmatic decisions on siting and technology. This includes preparing this PEIS and the associated Record of Decision (ROD). The ROD may include the following programmatic decisions:

- Whether to build new tritium supply and new or upgraded tritium recycling facilities;
- Where to locate tritium supply and recycling facilities;
- Which technology to employ for tritium supply.

**Time Frame of Proposed Action:**

- **1999 to 2009—Construction.**
- **2010 Initial Operation.**
- **2010 to 2050—Full Operation.**

During the second phase, DOE will develop detailed designs and meet project-specific *National Environmental Policy Act* (NEPA) requirements which would focus on where on a particular site the facility would be placed and construction and operation impacts. The third phase will involve constructing, testing, and certifying the selected tritium supply and recycling facilities, leading to full operation. Present plans are to have the tritium supply facilities fully operational by the year 2010 with new tritium available for use approximately 1 year later.

Following publication of the ROD, DOE will develop a schedule as part of the plan to implement the ROD decision. The schedule will be subject to change and include reassessments required by congressional authorizations and appropriations. Because of the many uncertainties associated with this proposal, assumptions were made regarding the time periods used in the PEIS analyses. For example, the PEIS assumes an environmental baseline period for construction between 1999 and 2009, and an operational period beginning in 2010 and extending for 40 years. Project-level NEPA documents will identify in detail the specific construction and operational periods for each project implemented.

## PURPOSE OF AND NEED FOR THE DEPARTMENT OF ENERGY'S ACTION

Since nuclear weapons came into existence in 1945, a nuclear deterrent has been a cornerstone of the Nation's defense policy and national security. The President reiterated this principle in his July 3, 1993, radio address to the Nation. Tritium is used to enhance the yield of nuclear weapons and allows for the production of smaller or more powerful weapons. The United States has based its strategic nuclear systems on designs that use tritium and, consequently, requires a reliable supply source. Tritium has a relatively short radioactive half-life of 12.3 years. Because of this relatively rapid radioactive decay, tritium must be replenished periodically in nuclear weapons to ensure that they will function as designed. Over the past 40 years, DOE has built and operated 14 reactors to produce nuclear materials, including tritium. Today, none of these reactors are operational, and no tritium has been produced since 1988.

Pursuant to the *Atomic Energy Act* of 1954, as amended, DOE is responsible for developing and maintaining the capability to produce tritium and other nuclear materials, which are required for the defense of the United States. The primary use of tritium is for maintaining the Nation's stockpile of nuclear weapons as directed by the President in the Nuclear Weapon Stockpile Plan (section 1.4.1).

The Nuclear Weapons Stockpile Plan is forwarded annually from the Secretaries of the Departments of Energy and Defense via the National Security Council to the President for approval. The Nuclear Weapons Stockpile Plan reflects the size and composition of the stockpile needed to defend the United States and provides an assessment of the DOE's ability to support the proposed stockpile. Many factors are considered in the development of the Nuclear Weapons Stockpile Plan, including the status of the currently approved stockpile, arms control negotiations and treaties, Congressional constraints, and the status of the nuclear material production and fabrication facilities. Revisions of the Nuclear Weapons Stockpile Plan could be issued when any of the factors indicate the need to change requirements established in the annual document. The current Nuclear Weapons Stockpile Plan, which was approved by President Clinton on March 7, 1994, authorizes weapons production and retirement through fiscal year 1999. The analysis in this PEIS is based on the requirements of the Nuclear Weapons Stockpile Plan. Appendix CA, which is classified, contains quantitative projections for tritium requirements based on the 1994 Nuclear Weapons Stockpile Plan, and details of the transportation analysis.

Even with a reduced nuclear weapons stockpile and no identified requirements for new nuclear weapons production in the foreseeable future, an assured long-term tritium supply and recycling capability will be required. Presently, no source of new tritium is available. The effectiveness of the United States nuclear deterrent capability depends not only on the Nation's current stockpile of nuclear weapons or those it can produce, but also on its ability to reliably and safely provide the tritium needed to support these weapons.

Until a new tritium supply source is operational, DOE will continue to support tritium requirements by recycling tritium from weapons retired from the Nation's nuclear weapons stockpile. However, because tritium decays relatively quickly, recycling can meet the tritium demands for a limited time. Current projections, derived from classified projections of future stockpile scenarios, indicate that recycled tritium will adequately support the Nation's nuclear weapons stockpile until approximately 2011. After that time, without a new tritium supply source, it would be necessary to utilize the strategic reserve of tritium in order to maintain the readiness of the nuclear weapons stockpile. The strategic reserve of tritium contains a quantity of tritium maintained for emergencies and contingencies. In such a scenario, once the strategic tritium reserve was depleted, the nuclear deterrent capability would degrade because the weapons in the stockpile would not be capable of functioning as designed. Eventually, the nuclear deterrent would be lost. The proposed tritium supply and recycling facilities would provide the capability to produce tritium safely and reliably in order to meet the Nation's defense requirements well into the 21st century while also complying with environment, safety, and health (ES&H) standards.

**Tritium, with a 12.3-year half-life, decays at the rate of approximately 5 percent per year and is necessary for all nuclear weapons that remain in the stockpile.**

DOE has analyzed the activities that must take place in order to bring a new tritium supply source into operation. The analysis indicates that it will take approximately 15 years to research, develop, design, construct, and test a new tritium supply source before new tritium production can begin. Thus, in order to have reasonable confidence that the Nation will be able to maintain an effective nuclear deterrent, prudent management dictates that DOE proceed with the proposed action now. In addition, DOE must meet a statutory deadline of March 1, 1995, to issue a PEIS addressing tritium supply alternatives (Public Law 103-160, section 3145).

## ALTERNATIVES

The alternatives considered for tritium supply and recycling consist of four different supply technologies and five locations (figure S–2). The four technologies to provide a new supply of tritium are: Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), Advanced Light Water Reactor (ALWR), and Accelerator Production of Tritium (APT). The five candidate sites evaluated for such a facility are INEL, Nevada Test Site (NTS), Oak Ridge Reservation (ORR), Pantex Plant, and Savannah River Site (SRS).

### No Action

To satisfy NEPA requirements, No Action is presented for comparison with the action alternatives. Under No Action, DOE would not establish a new tritium supply capability, the current inventory of tritium would decay, and DOE would not meet stockpile requirements. The current DOE missions at each candidate site are assumed to continue under No Action.

### Tritium Supply and Recycling

The tritium supply technologies and site alternatives are described below. For each alternative except for alternatives at SRS, a new tritium recycling facility could either be collocated with the new tritium supply facilities or use the existing recycling facilities at SRS after upgrade. For the alternatives at SRS, the new tritium supply facility would utilize existing recycling facilities at SRS that would be upgraded to support the tritium mission.

#### Technologies

**Heavy Water Reactor.** The HWR would be a low pressure, low temperature reactor whose sole purpose would be to produce tritium. The HWR would use heavy water as the reactor coolant and moderator. Because of the low temperature of the exit coolant, a power conversion system designed to produce electrical power as an option would not be feasible. The conceptual design of the HWR complex includes a fuel and target fabrication facility, a tritium target processing facility, an interim spent fuel storage building, a general services building, and a security infrastructure. The HWR complex would cover approximately 260 acres. Construction of the HWR would take somewhat less than 8 years and require approximately 2,320 workers during the peak construction period. Operation of the HWR would require approximately 930 workers.

**Modular High Temperature Gas-Cooled Reactor.** The MHTGR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium. Three 350 MWt reactors would be required to produce the goal quantities of tritium. The MHTGR would use helium gas as a core coolant and graphite as a moderator. Because of the high temperature of the exit coolant, a power conversion facility designed to produce electricity is an integral part of the design and is included in the analysis. The design of the MHTGR complex, in addition to three reactors, would include a fuel and target fabrication facility, a tritium target processing facility, helium storage buildings, waste treatment facilities, spent fuel storage facility, a general services building, a security infrastructure, and a power conversion facility consisting of three turbine- generators and associated electrical control equipment. The MHTGR complex would cover approximately 360 acres. Construction of the MHTGR would take about 9 years and require approximately 2,210 workers during the peak construction period. Operation of the MHTGR would require approximately 910 workers.

A modular gas-cooled reactor like the MGTGR would also be capable of performing the "triple play" missions of producing tritium, burning plutonium, and generating electricity. To burn plutonium in a gas-cooled reactor, a plutonium pit disassembly/conversion/plutonium-oxide fuel fabrication facility would be needed. Additionally, because tritium pro-

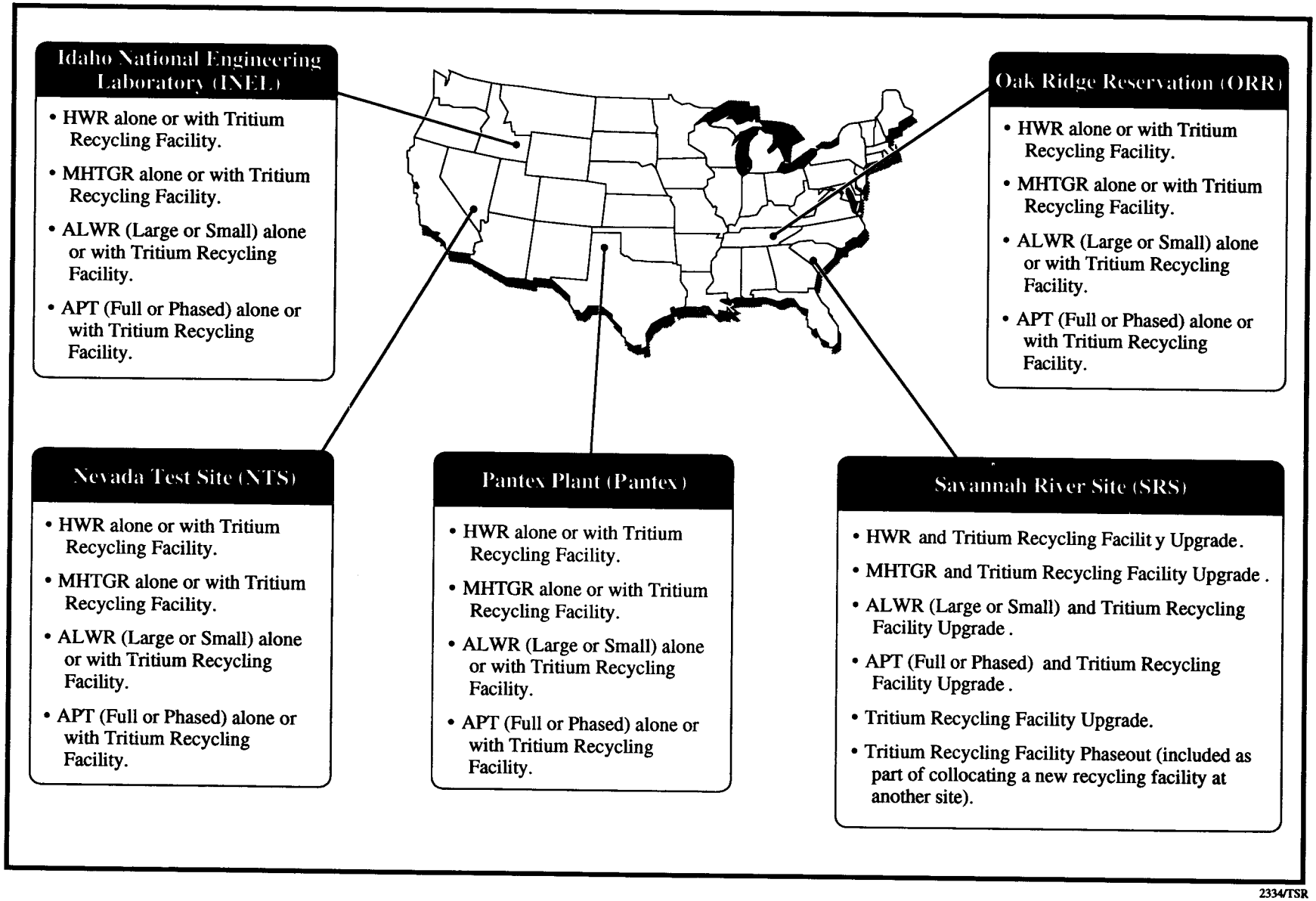


**FIGURE S–2.—*Tritium Supply and Recycling Alternatives.***

duction decreases significantly in a plutonium-fueled gas-cooled reactor, twice as many reactor modules would be necessary in order to produce the steady-state tritium requirements. This doubling of reactor modules would be the major contributor to potential environmental impacts for this scenario. The PEIS contains an assessment of these potential environmental impacts.

**Range of Selected Construction Requirements for Tritium Supply Technologies:**

- **Electrical Energy Demand:**
  40,000 to 120,000 MWh
- **Land Use:**
  173 to 360 acres
- **Total Number of Construction Workers:**
  1,350 to 3,500
- **Water Consumption:**
  41,700,000 to 200,000,000 gal (over a 5-9 year period)
- **Steel Consumption:**
  45,000 to 68,000 tons

**Advanced Light Water Reactor.** The ALWR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium. There are two options for the ALWR technology: a Large ALWR (1300 MWe) and a Small ALWR (600 MWe). The large and small options include four candidates: a large or small pressurized water reactor or a large or small boiling water reactor. All ALWR options would use light (regular) water as the reactor coolant and moderator. Like the MHTGR, a power conversion facility is an integral part of the design for the ALWR because of the high temperature of the exit coolant. The design of the ALWR complex would include an interim spent fuel storage building, a waste treatment facility, a tritium target processing facility, warehouses, a power conversion facility, and security infrastructure. Unlike the other technologies, the ALWR would not have a fuel fabrication facility since fuel rods would be obtained from offsite sources. The ALWR complex would cover approximately 350 acres. Construction of the ALWR would take about 6 years and require approximately 3,500 workers for the Large ALWR and 2,200 workers for the Small ALWR during the peak construction period. Operation of the Large ALWR would require approximately 830 workers and the Small ALWR would require approximately 500 workers.

An ALWR would also be capable of performing the "triple play" missions of producing tritium, burning plutonium, and generating electricity. The multipurpose ALWR would operate essentially the same as a uranium-fueled tritium production ALWR. Therefore, the environmental impacts from operation of a multipurpose ALWR would be expected to be unchanged from the tritium production ALWR. To burn plutonium in an ALWR, a plutonium pit disassembly/conversion/mixed-oxide fuel fabrication facility would be needed to provide the mixed-oxide fuel rods for the ALWR, and would be the major contributor to potential environmental impacts for this scenario. The PEIS contains an assessment of these potential environmental impacts.

**Accelerator Production of Tritium.** The APT would be a linear accelerator whose purpose would be to produce tritium. The APT accelerates a proton beam in a long tunnel toward one of two target/blanket assemblies located in separate target stations. There are two target/blanket concepts being considered in the conceptual design of the APT: the spallation-induced lithium conversion target and the helium-3 target. The accelerator, 3,940 feet in length, would be housed in a concrete tunnel buried 40 to 50 feet underground. The APT facility would require a peak electrical load of approximately 550 MWe to produce the 3/8 goal tritium quantity, and 355 MWe to produce the steady-state tritium requirement. The conceptual design of the APT complex would include: a target building that would house the target chambers located in a subterranean structure at the same level as the accelerator; a tritium processing facility to extract tritium from the targets; a klystron remanufacturing and maintenance facility; waste treatment buildings to treat all generated wastes; security infrastructures and various administration, operation, and maintenance facilities. The APT complex would cover approximately 173 acres. Construction of the APT would take about 5 years and require approximately 1,350 workers during the peak construction period. Operation of the APT would require approximately 624 workers. A phased construction approach to the APT is also an option.

**Range of Selected Operation Requirements for Tritium Supply Technologies:**

- **Electrical Energy Demand:**
  260,000 to 3,740,000 MWh/yr.
- **Land Use:**
  173 to 360 acres.
- **Total Number of Operation Workers:**
  624 to 930.
- **Water Consumption (gal per year):**
  0.03 to 16 billion.
- **Spent Nuclear Fuel Generation:**
  0 to 80 cubic yards per year.

**Sites**

**The Idaho National Engineering Laboratory.** INEL was established in 1949 and currently occupies approximately 570,000 acres near Idaho Falls, ID. INEL performs research and development activities on reactor performance; conducts materials testing and environmental monitoring activities; performs research and development activities for the processing of waste; conducts breeder reactor research; and is a naval reactor training site. There are currently no Defense Program missions at INEL.

**Nevada Test Site.** NTS was established in 1950 and currently occupies approximately 864,000 acres located 65 miles northwest of Las Vegas, NV. The site has conducted underground testing of nuclear weapons and evaluations of the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. In October 1992, underground nuclear testing was halted, yet the site maintains the capability to resume testing if authorized by the President. There are currently two Defense Program missions at NTS: maintain underground nuclear testing program capabilities and maintain nuclear emergency search team program capabilities.

**Oak Ridge Reservation.** ORR was established in 1942 as part of the World War II Manhattan Project and is located on approximately 35,000 acres within the city boundaries of Oak Ridge, TN. It includes three major facilities: Oak Ridge National Laboratory; Y-12 Plant (Y-12); and the K-25 Site (the former Oak Ridge Gaseous Diffusion Plant). Y-12 is the primary location of Defense Program missions. The Y-12 assignment includes the dismantling of nuclear weapons components returned from the Nation's arsenal, maintaining nuclear production capability and stockpile support, storing special nuclear materials, and providing special manufacturing support to DOE programs. In addition to the four Defense Program missions identified above, ORR also has the mission to fabricate uranium and lithium components and parts for nuclear weapons.

**Pantex Plant.** Pantex was established in 1951 and currently occupies approximately 16,000 acres near Amarillo, TX. The current Defense Program missions at Pantex are to assemble and disassemble nuclear weapons; perform weapons repair, modification, and disposal; conduct stockpile evaluation and testing; and provide interim storage for plutonium. Pantex is the only DOE facility that can execute the final assembly of a nuclear weapon for the Department of Defense stockpile.

**Savannah River Site.** SRS was established in 1950 as a nuclear materials production site and occupies approximately 192,000 acres south of Aiken, SC. The major nuclear facilities at SRS have included fuel and target fabrication facilities; nuclear material production reactors; chemical separation plants used for recovery of plutonium and uranium isotopes; a uranium fuel processing area; and the Savannah River Technology Center that provides process support. The current Defense Program mission at SRS is to process tritium and conduct tritium recycling and reservoir filling in support of stockpile requirements. SRS also has the mission to process backlog targets and spent nuclear fuel.

## ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

By law, DOE is required to support the Nuclear Weapons Stockpile Plan. In order to do this, DOE must maintain a nuclear weapons production, maintenance, and surveillance capacity consistent with the

President's Stockpile Plan. For the proposed action, the following alternatives were considered but eliminated from detailed study for the reasons stated below.

**Purchase Tritium From Foreign Sources.** DOE has considered the purchase of tritium from other sources, including foreign nations. Conceptually, the purchase of tritium from foreign governments could provide a fraction of the tritium requirement. However, while there is no national policy against purchase of defense materials from foreign sources, DOE has determined that the uncertainties associated with obtaining tritium from foreign sources render this alternative unreasonable for an assured long-term supply.

**Redesign of Weapons to Require Less or No Tritium.** The nuclear warheads in the enduring stockpile were designed and built in an era when the tritium supply was assured, when underground nuclear testing was being conducted, and when military needs required that the warheads be optimized in terms of weight and volume. Replacing these warheads with new ones that would use little or no tritium for the sole reason of reducing overall tritium demand would be infeasible and unreasonable. Without underground nuclear testing to verify their safety and reliability, new warhead designs cannot deviate very far from current designs which require the use of tritium. Even with underground testing to facilitate new designs and a fully operational production complex, it would still take many years to build enough warheads to replace the enduring stockpile. Therefore, replacing the enduring stockpile of warheads with new designs would most likely take longer and could cost more than constructing and operating a new tritium supply facility. Because neither the President nor the Congress has approved that the government embark on a costly and expansive design, testing, and construction program solely to eliminate tritium requirements, weapons redesign to use less or no tritium is not a reasonable short- or long-term alternative.

**Use of Existing Department of Energy Reactors or Accelerators.** DOE (and its predecessor agencies) has designed, constructed, and operated a number of nuclear reactors over the past 50 years. The majority of these reactors were designed to assist in the development of nuclear research and safety standards development. DOE has also constructed nuclear reactors to produce the materials required to support the production and maintenance of nuclear weapons and has constructed nuclear reactors in support of the Naval Propulsion Program.

Among the first experimental reactors were the water boiler at Los Alamos National Laboratory and CP-3 at Argonne National Laboratory-West, which were completed in 1944. Since then, numerous experimental and research reactors were constructed for a variety of purposes, including material tests, new reactor concepts, and safety experiments. Only four DOE research reactors are currently in operation: the High Flux Isotope Reactor at Oak Ridge Reservation (ORR); the High Flux Beam Reactor at Brookhaven National Laboratory; and the Experimental Breeder Reactor-II and the Advanced Test Reactor at the Idaho National Engineering Laboratory (INEL). In addition, there are some low power/critical facilities supporting medical research (at Brookhaven) and supporting reactor core configuration research (at Argonne National Laboratory-West at INEL). None of these facilities is large enough to produce the amount of tritium required to support the projected stockpile requirements. All are currently committed to existing programs and were constructed in the early 1960s, rendering their design life reliability unsuitable for the time frame required for a new, assured, long-term tritium supply facility.

Of the existing DOE reactors that are currently not being operated, only one has the potential for producing any significant quantities of tritium: the Fast Flux Test Facility at the Hanford Site. This facility was designed and constructed to perform materials research for the national liquid-metal breeder reactor program. This small (440-megawatt thermal (MWt)) experimental reactor, based on liquid-metal reactor technology, could, after substantial core and cooling system modifications, as well as target technology development, have the potential to supply a significant percentage of the steady state tritium requirement. The Fast Flux Test Facility, however, was designed in the late 1970s and began operation in 1980. In 2010, it will already be 10 years past its design 20-year lifetime. Relying on the ability to modify and operate Fast Flux Test Facility well into the middle of the next century is not a reasonable alternative.

DOE also constructed and operated more than a dozen nuclear reactors for production of nuclear materials at SRS and the Hanford Site, starting with the early part of the Manhattan Project during World War II. None of these reactors is currently operational. Of those reactors specifically designed to produce nuclear materials for the nuclear weapons program, the K-Reactor at SRS is the only remaining reactor which could be capable of returning to operation. It is presently in a "cold stand-by state" and has not been operated since 1988. The reactor was shut down for major environmental, safety, and health upgrades, to comply with today's stringent standards. DOE discontinued the K-Reactor Restart Program when the reduced need for tritium to support a smaller stockpile delayed the need for tritium. In this context, reliance upon the ability to upgrade and operate well into the middle of the next century a first generation reactor designed in the 1940s is not a reasonable alternative for new, long-term, assured tritium supply.

DOE has been a world leader in the design and construction of particle accelerators, and currently operates six national facilities. Of the existing research accelerators, none is capable of producing significant quantities of tritium. The existing DOE research accelerators are all of the pulsed design and are only capable of producing low power accelerator beams in the 800 kilowatt (kW) range. A production accelerator facility, utilizing continuous wave operation, would be required to deliver a high power proton beam of 100 megawatt (MW) for tritium production. None of the existing research accelerators could be reasonably upgraded to meet the long-term, assured tritium requirements.

**Use of Commercial Reactors.** Tritium could be produced directly in existing light water reactors by irradiating target rods made from lithium. However, the production of tritium for defense purposes in nuclear reactors that generate electricity for commercial sale would be contrary to the long-standing U.S. policy that civilian nuclear facilities should not be utilized for military purposes. Such use of commercial reactors would make the United States nonproliferation efforts much more difficult because other countries could demand equal footing. For this reason, DOE does not consider the use of commercial reactors to be a reasonable alternative for a long-term assured supply of tritium to be evaluated in the PEIS. However, as previously discussed, the PEIS will contain an evaluation of the impacts associated with the use of an existing light water reactor to produce tritium, whether an existing reactor were used on a contingency basis to produce tritium in a national emergency, or the Department chose at some future date to purchase an existing reactor and convert it to defense purposes as a long-term source of tritium. Therefore, a discussion of the generic environmental impacts of the production of tritium in a commercial reactor is presented in section 4.10.

**Alternative Sites.** Section 3.3.1 describes the process that was carried out to identify the range of reasonable site alternatives for the tritium supply and recycling facilities that are considered in this PEIS. The process of determining these reasonable tritium supply alternative sites has been evolutionary, starting with the engineering studies and criteria developed by the New Production Reactor program, then utilizing additional criteria and considerations from the Reconfiguration Program, information related to changing missions at DOE sites, and input from public scoping.

During the preparation of this Draft PEIS, the Department has continued to assess other alternative sites. In fact, once the APT was added as a potential tritium supply technology, an assessment was conducted to determine if the Los Alamos National Laboratory, which operates a linear accelerator and is the home of significant accelerator expertise, would be a reasonable site for a tritium producing accelerator.

The APT conceptual designs for tritium supply have established that evaporative cooling towers would be used to dissipate the heat generated in the tritium target assemblies and in the accelerator facility. These APT cooling water requirements are significantly greater than the current regulated allotment of water for Los Alamos National Laboratory and increasing the allotment to support the APT water requirement would be impractical and infeasible, and in any event beyond DOE's control.

It may be possible that an APT could use non-evaporative cooling towers which would greatly reduce the water requirements. However, there is sufficient technical uncertainty regarding the feasibility and practicality of using non-evaporative cooling towers

for a continuous wave APT to render this option unacceptable as a source for the Nation's only supply of tritium. The other five sites being analyzed in this PEIS could reasonably support the water requirements of the APT using evaporative cooling towers and, thus, would not incur the technical uncertainty and risk of Los Alamos National Laboratory. Thus, DOE has concluded that Los Alamos National Laboratory is not a reasonable site for an accelerator to produce tritium (LA DOE 1994a:1).

## ENVIRONMENTAL IMPACTS

In accordance with CEQ regulations, the environmental consequences discussions provide the analytical detail for comparisons of environmental impacts associated with the various tritium supply technologies and recycling facilities. Discussions are provided for each DOE site and each environmental resource and relevant issues that could be affected.

For comparison purposes, environmental concentrations of emissions and other potential environmental effects are presented with appropriate regulatory standards or guidelines. However, the compliance with regulatory standards is not necessarily an indication of the significance or severity of the environmental impact for NEPA purposes.

The purpose of the analysis of environmental consequences is to identify the potential for environmental impacts. The environmental assessment methods used and the factors considered in assessing environmental impacts are discussed in section 4.1, Environmental Resource Methodologies, and in the appropriate appendixes. The potential for impacts to a given resource or relevant issue is described in the introduction to each section within the site discussions (sections 4.2 through 4.10). A brief narrative summary of the impacts by site and resource or relevant issues follows.

For the resource or issue area, the summary presents the range of impacts (high and low) and associated technology collocated with tritium recycling. For a more detailed summary comparison of impacts for the tritium supply and recycling alternatives, the reader is referred to section 3.6 and appendix I.

### Idaho National Engineering Laboratory

*Land Resources.* Construction and operation of a tritium supply would disturb between 173 acres (APT) and 360 acres (MHTGR). Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation. Siting any of the tritium supply technologies alone or collocated with recycling at INEL would be consistent with site development plans. No visual impacts are expected.

*Site Infrastructure.* New site infrastructure (e.g., roads and transmission lines) would be required to support all technologies. The power requirements would exceed the current site electrical requirements of 93 MWe by 11 MWe (MHTGR) to 515 MWe (APT).

*Air Quality and Acoustics.* Construction activities would result in exceedance of 24-hour $PM_{10}$ and state TSP standards. Air pollutant concentrations would increase during operation but would be within standards. An increase in onsite noise would result from construction and operation of a tritium supply. Offsite noise impacts would be negligible.

*Water Resources.* Surface waters would not be affected by construction or operation. Groundwater use would range from 10 MGY (APT) to 35 MGY (Large ALWR) during construction. Operation water requirements would range from 43 MGY (MHTGR) to 2,656 MGY (APT). Total groundwater use for all the reactor technologies except APT would be approximately 18 percent of the INEL groundwater allotment. The APT total groundwater use for operation represents approximately 41 percent of the INEL groundwater allotment.

*Geology and Soils.* Construction and operation would neither affect nor be affected by geological conditions. The soil disturbed area would range from 375 acres (APT) to 562 acres (MHTGR). Soil erosion due to wind and stormwater runoff would be minor.

*Biotic Resources.* During construction and operation, terrestrial resources would be affected by the disturbance of between 375 acres (APT) and 562 acres (MHTGR) of habitat. Impacts from salt drift are possible with the APT. Wetlands and aquatic

resources would not be affected. No Federal-listed, threatened, or endangered species would be affected, but several Federal candidate or state-listed species may be affected.

*Cultural and Paleontological Resources.* Some NRHP-eligible prehistoric and historic resources may occur within the disturbed area. Native American resources may be affected by land disturbance and audio or visual intrusions. The HWR and ALWR would not be expected to affect paleontological resources. However, the MHTGR and APT may affect paleontological resources where excavations could extend down to 50 feet or deeper.

*Socioeconomics.* Employment in the economic study area would increase by 4,800 (APT) to 10,800 persons (either ALWR) during peak construction. Employment during full operation would increase in the economic study area by 4,100 (APT) to 4,900 persons (HWR and MHTGR). Unemployment would decrease from 6.4 percent, the projected baseline, to 4.5 percent for all technologies during peak construction and 4.9 (APT) to 4.6 percent (HWR and MHTGR) during full operation. Per capita income would increase by an annual average of approximately 1 percent during peak construction and full operation for every technology except HWR, which would increase by 1 to 2 percent during peak construction and 2 percent during full operation.

Population and housing demand within the region of influence would increase by between 2 percent (APT) and 9 percent (ALWR) during construction and approximately 2 percent for all technologies during operation.

For every technology except ALWR, total revenues and expenditures for most region-of-influence (ROI) counties, cities, and school districts would increase by an annual average of between 2 and less than 1 percent through 2005 and between 1 and 0 percent through 2010. For either ALWR, total revenues and expenditures within the region of influence would increase between 4 and less than 1 percent in the first 3 years of construction and decrease 1 to 2 percent annually through 2010. Total revenues and expenditures for all technologies would increase by annual averages of less than 1 percent through 2020.

Traffic conditions on access roads to INEL are expected to degrade due to increased worker traffic and congestion, particularly on U.S. Route 20/26, the primary access route.

*Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents.* The dose to the maximally exposed member of the public from total site operation for 1 year would range from 0.11 (APT with helium-3 target) to 0.36 (ALWR) mrem. The associated risk of fatal cancer from 40 years of operation would range from $2.3 \times 10^{-6}$ to $7.3 \times 10^{-6}$, respectively.

The annual 50-mile population dose from total site operation in 2030 would range from 23 (APT with helium-3 target) to 73 (Large ALWR) person-rem and could result in 0.45 to 1.5 fatal cancers over 40 years of operation.

The average annual dose to a site worker would range from 31 (MHTGR) to 49 (Large ALWR) mrem with the associated risk of fatal cancer from 40 years of operation ranging from $5.0 \times 10^{-4}$ to $7.9 \times 10^{-4}$, respectively. The annual dose to the total site workforce would range from 250 (MHTGR) to 392 (Large ALWR) person-rem and could result in 4.0 to 6.3 fatal cancers over 40 years of operation. All doses to the public and to site workers are within regulatory limits.

Any exposures to site workers and the public resulting from emissions of hazardous chemicals are expected to be within regulatory limits and have negligible cancer risk.

For low to moderate consequence/ high probability accidents, the doses and risks associated with the APT are negligible. For the technology with the most severe consequences, the Large ALWR, the dose to a maximally exposed individual at the site boundary would be 5.1 rem. This dose would result in an increased likelihood of cancer fatality of $2.5 \times 10^{-3}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $2.5 \times 10^{-6}$ per year. For the population residing within 50 miles of the accident (150,000), the dose would be $4.5 \times 10^{4}$ person-rem with an associated annual cancer risk of 0.023. If this accident occurred, this exposure would result in 23 cancer fatalities.

For high consequence/low probability accidents, the dose to a maximally exposed individual at the site

boundary is small for the APT. The highest dose is for the Large ALWR which is 166 rem. This dose would result in an increased likelihood of cancer fatality of $3.7 \times 10^{-3}$. Given an accident probability of $2.0 \times 10^{-8}$ per year the cancer risk would be $7.4 \times 10^{-11}$ per year. For the population residing within 50 miles of the accident (150,000), the dose would be $5.7 \times 10^{5}$ person-rem with an associated annual cancer risk of $5.6 \times 10^{-6}$. If this accident occurred, this exposure would result in 282 cancer fatalities.

*Waste Management.* Spent nuclear fuel would be generated by the HWR, MHTGR, and ALWR, and require a new storage facility. The APT would not generate spent fuel. Liquid low-level waste would be generated by every technology except APT. Existing treatment facility may be adequate for all technologies except the Large ALWR. Solid low-level waste would be generated and require between 3 (APT and Small ALWR) and 15 acres per year (HWR) of onsite LLW disposal area. The generation of liquid mixed low-level waste would be negligible for all technologies. Solid mixed low-level waste would increase by 3 cubic yards per year (MHTGR) to 122 cubic yards per year (HWR). The HWR increase may require new or expanded treatment and storage facilities.

Hazardous waste generation would increase by approximately 4 cubic yards per year (APT) to 101 cubic yards per year (MHTGR). The use of existing hazardous waste management facilities is feasible. All technologies would generate liquid sanitary waste and require new treatment facilities. Solid sanitary waste generation would increase by 8,640 cubic yards per year (APT) to 15,000 cubic yards per year (HWR). Existing landfill design life would be reduced or require expansion. Other solid nonhazardous wastes would be recycled.

*Intersite Transport.* For all technologies, the relative risk associated with transporting tritium is 29 percent lower than the existing case (No Action) because the distance travelled is shorter. The potential cancer fatalities per year for transporting tritiated heavy water is $3.57 \times 10^{-5}$ (HWR) and $6.63 \times 10^{-6}$ (APT) for both tritium supply alone and supply with recycling. There is no intersite transport of LLW for any technology. The risk of transporting new tritium for supply alone is about 2 percent greater than No Action (due to transporting new tritium to SRS).

**Nevada Test Site**

*Land Resources.* Construction and operation of a tritium supply would disturb between 173 acres (APT) and 360 acres (MHTGR). Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operations. Siting any of the tritium supply technologies alone or collocated with recycling at NTS would be consistent with site development plans. Some visual impacts are expected.

*Site Infrastructure.* New site infrastructure (e.g., roads and transmission lines) would be required to support all technologies. The power requirements would exceed the current site electrical requirement of 28 MWe by 55 MWe (MHTGR) to 559 MWe (APT).

*Air Quality and Acoustics.* Construction activities would result in exceedance of 24-hour $PM_{10}$ and state TSP standards. Air pollutant concentrations would increase during operation but would be within standards. An increase in onsite noise would result from construction and operation of a tritium supply. Offsite noise impacts would be negligible.

*Water Resources.* Surface waters would not be affected by construction or operation. Groundwater use would range from 10 MGY (APT) to 35 MGY (Large ALWR) during construction. Operation water requirements would range from 43 MGY (MHTGR) to 2,656 MGY (APT). Total site groundwater withdrawals would not exceed the lowest estimated aquifer recharge rate except for the APT.

*Geology and Soils.* Construction and operation would neither affect nor be affected by geological conditions. The soil disturbed area would range from 375 acres (APT) to 562 acres (MHTGR). Soil erosion due to wind and stormwater runoff would be minor.

*Biotic Resources.* During construction and operation, terrestrial resources would be affected by the disturbance of between 375 acres (APT) and 562 acres (MHTGR) of habitat. Impacts from salt drift are possible with the APT. Wetlands and aquatic

resources would not be affected. One Federal-listed, threatened species, the desert tortoise, may be affected and several Federal candidate or state-listed species may also be affected.

*Cultural and Paleontological Resources.* Some NRHP-eligible prehistoric and historic resources may occur within the disturbed area. Native American resources may be affected by land disturbance and audio or visual intrusions. Paleontological resources may also be affected.

*Socioeconomics.* Employment in the economic study area would increase by 6,000 (APT) to 13,700 persons (either ALWR) during peak construction. Employment during full operation would increase in the economic study area by 4,600 (APT) to 5,500 persons (HWR and MHTGR). Unemployment would decrease from 5 percent, the projected baseline, to between 3.9 (HWR, MHTGR, and ALWR) and 4 percent (APT) during peak construction and to between 4.3 (HWR) and 4.5 percent (APT) during full operation. Per capita income would increase by an annual average of approximately 1 percent during peak construction and full operation for each technology.

Population and housing demand within the ROI would increase by between 1 percent (HWR, MHTGR, and APT) and 2 percent (ALWR) during construction and by less than 1 percent for all technologies during operation.

For each technology, total revenues and expenditures for all region of influence counties, cities, and school districts would increase by annual averages of between 4 and less than 1 percent through 2005, between 1 and 2 percent through 2010, and by less than 1 percent annually through 2020.

Traffic conditions on access roads to NTS are expected to degrade due to increased worker traffic and congestion, particularly on Mercury Highway, the primary access route.

*Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents.* The dose to the maximally exposed member of the public from total site operation for 1 year would range from 0.13 (APT with helium-3 target) to 0.4 (ALWR) mrem. The associated risk of fatal cancer from 40 years of operation would range from $2.6 \times 10^{-6}$ to $8.0 \times 10^{-6}$, respectively.

The annual 50-mile population dose from total site operation in 2030 could range from 0.08 (APT with helium-3 target) to 0.25 (Small ALWR) person-rem and could result in $1.6 \times 10^{-3}$ to $5.1 \times 10^{-3}$ fatal cancers over 40 years of operation.

The average annual dose to a site worker would range from 26 (MHTGR) to 140 (Large ALWR) mrem with the associated risk of fatal cancer from 40 years of operation ranging from $4.2 \times 10^{-4}$ to $2.3 \times 10^{-3}$, respectively. The annual dose to the total site workforce would range from 33 (MHTGR) to 180 (Large ALWR) person-rem and could result in 0.53 to 2.8 fatal cancers over 40 years of operation. All doses to the public and to site workers are within regulatory limits.

Any exposures to site workers and the public resulting from emissions of hazardous chemicals are expected to be within regulatory limits and have negligible cancer risk.

For low to moderate consequence/high probability accidents associated with operation, the doses and risks associated with the APT are negligible. For the technology with the most severe consequences, the Large ALWR, the dose to a maximally exposed individual at the site boundary would be 2.3 rem. This dose would result in an increased likelihood of cancer fatality of $1.1 \times 10^{-3}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $1.1 \times 10^{-6}$ per year. For the population residing within 50 miles of the accident (18,000), the dose would be 830 person-rem with an associated annual cancer risk of $4.1 \times 10^{-4}$. If this accident occurred, this exposure would result in 0.41 cancer fatalities.

For high consequence/low probability accidents associated with operation, the dose to a maximally exposed individual at the site boundary would be small for the APT and 284 rem for an ALWR. This dose would result in an increased likelihood of cancer fatality of $6.7 \times 10^{-3}$. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $1.3 \times 10^{-10}$. For the population residing within 50 miles of the accident (18,000), the dose would be $5.7 \times 10^{4}$ (Small ALWR) person-rem with an associated annual cancer

risk of $5.7 \times 10^{-7}$ per year. If this accident occurred, this exposure would result in 28 cancer fatalities.

*Waste Management.* Spent nuclear fuel would be generated by the HWR, MHTGR, and ALWR, and require a new storage facility. The APT would not generate spent fuel. Liquid low-level waste would be generated by every technology except APT and would require new or separate treatment facilities. Solid low-level waste would be generated and require between 2.5 (APT and Small ALWR) and 13.5 acres per year (HWR) of onsite LLW disposal area. Liquid mixed low-level waste would be generated by each technology and would require an organic mixed waste treatment capability. Solid mixed low-level waste would increase by 3 cubic yards per year (MHTGR) to 122 cubic yards per year (HWR) and would require an organic mixed waste treatment capability.

Hazardous waste generation would increase by 4 cubic yards per year (APT) to 101 cubic yards per year (MHTGR). Separate or expanded hazardous waste management facilities may be required for all technologies except APT. All technologies would generate liquid sanitary waste and require new or separate treatment facilities. Solid sanitary waste generation would increase by 8,640 cubic yards per year (APT) to 15,000 cubic yards per year (HWR). Existing landfill design life would be reduced or require expansion. Other solid nonhazardous wastes would be recycled.

*Intersite Transport.* For all technologies, the relative risk associated with transporting tritium is 30 percent lower than the existing case (No Action) because the distance travelled is shorter. The potential cancer fatalities per year from transporting tritiated heavy water is $3.57 \times 10^{-5}$ (HWR) and $6.63 \times 10^{-6}$ (APT). There is no intersite transport of LLW for any technology. The risk of transporting new tritium for supply alone is about 2 percent greater than No Action (due to transporting new tritium to SRS).

**Oak Ridge Reservation**

*Land Resources.* Construction and operation of a tritium supply technology would disturb between 173 acres (APT) and 360 acres (MHTGR). Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation. Siting any of the tritium supply technologies alone or collocated with recycling at ORR would disturb some land designated as National Environmental Research Park. Some visual impacts are expected.

*Site Infrastructure.* No new site infrastructure (e.g., roads and transmission lines) would be required to support any technologies. The power requirements would be less than the current site electrical requirement of 1,411 MWe by 1,252 MWe (MHTGR) to 738 MWe (APT).

*Air Quality and Acoustics.* Construction would result in exceedance of 24-hour $PM_{10}$ and state TSP standards. Air pollutant concentrations would increase during operation but would be within standards. An increase in onsite noise would result from construction and operation of a tritium supply. Offsite noise impacts would be negligible.

*Water Resources.* Surface water use would range from 10 MGY (APT) to 35 MGY (Large ALWR) during construction. Operation surface water requirements would range from 2,677 MGY (APT) to 16,035 MGY (Large ALWR). These represent increases of between less than 1 and 2 percent during construction and 145 and 867 percent during operation. Blowdown discharges to surface waters would range from 528 MGY (APT) to 6,209 MGY (Large ALWR). Groundwater would not be affected by construction or operation.

*Geology and Soils.* Construction and operation would neither affect nor be affected by geological conditions. The soil disturbed area would range from 375 acres (APT) to 562 acres (MHTGR). Soil erosion due to wind and stormwater runoff would be minor.

*Biotic Resources.* During construction and operation, terrestrial resources would be affected by the disturbance of between 375 acres (APT) and 562 acres (MHTGR) of habitat. Salt drift from an evaporative cooling system could impact an additional limited acreage for all technologies. Increased stream flow from construction and operational discharges could affect wetland and aquatic plant communities. No Federal-listed, threatened, or endangered species would be affected, but several state-listed species may be affected.

*Cultural and Paleontological Resources.* Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. Native American resources may be affected by land disturbance and audio or visual intrusions. Paleontological resources may be affected, but impacts would be negligible.

*Socioeconomics.* Employment in the economic study area for collocated tritium supply and recycling would increase between 5,300 (APT and recycling) and 12,000 (ALWR) persons during construction. Employment during operation would increase in the economic study area between 4,300 (APT) and 5,200 (HWR) persons. Unemployment would decrease from 6.2 percent, the projected baseline, to between 4.8 (ALWR) and 5.5 (APT) percent during construction and to between 5.6 (HWR, MHTGR, and ALWR) and 5.7 (APT) percent during operation. Per capita income would increase by an average of 1 percent for all technologies during construction and operation.

Population and housing demand in the ROI would increase by between less than 1 percent (HWR, MHTGR, and APT) and less than 2 percent (ALWR) during construction and by less than 1 percent for all technologies during operation.

For each technology, total revenues and expenditures for most ROI counties, cities, and school districts would increase by annual averages of approximately 1 percent or less through 2010, and by less than 1 percent through 2020.

Traffic conditions on access roads to ORR are expected to degrade due to increased worker traffic and congestion, particularly on Bear Creek Road, the primary access route.

*Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents.* The dose to the maximally exposed member of the public from total site operation for 1 year would range from 4.3 (APT with helium-3 target) to 8.8 (Large ALWR) mrem for atmospheric release and would be 14 mrem for liquid release for all technologies. The associated risks of fatal cancer from 40 years of operation would be $8.6 \times 10^{-5}$, $1.8 \times 10^{-4}$, and $2.7 \times 10^{-4}$ ($2.8 \times 10^{-4}$for ALWRs), respectively.

The annual 50-mile population dose from total site operation in 2030 would range from 68 (APT with helium-3 target) to 90 (Large ALWR) person-rem and could result in 1.4 to 1.8 fatal cancers over 40 years of operation.

The average annual dose to a site worker would range from 18 (MHTGR) to 26 (Large ALWR) mrem with the associated risk of fatal cancer from 40 years of operation ranging from $2.9 \times 10^{-4}$ to $4.2 \times 10^{-4}$, respectively. The annual dose to the total site workforce would range from 350 (MHTGR) to 490 (Large ALWR) person-rem and could result in 5.6 to 7.9 fatal cancers over 40 years of operation. All doses to the public and to site workers are within regulatory limits.

Any exposures to site workers and the public resulting from emissions of hazardous chemicals are expected to be within regulatory limits and have negligible cancer risk.

For low to moderate consequence/ high probability accidents associated with operation, the doses and risks associated with the APT are negligible. For the technology with the most severe consequences, the Large ALWR, the dose to a maximally exposed individual at the site boundary would be 44 rem. This dose would result in an increased likelihood of cancer fatality of $4.4 \times 10^{-2}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $4.4 \times 10^{-5}$ per year. For the population residing within 50 miles of the accident (1,062,000), the dose would be $4.9 \times 10^{4}$ person-rem with an associated annual cancer risk of 0.24. If this accident occurred, this exposure would result in 240 cancer fatalities.

For high consequence/low probability accidents associated with operation, the dose to a maximally exposed individual at the site boundary would be small for the APT and $5.3 \times 10^{3}$ rem for an ALWR. This dose would result in an increased likelihood of cancer fatality of 0.16 per year. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $3.2 \times 10^{-9}$ per year. For the population residing within 50 miles of the accident (1,062,000), the dose would be $4.4 \times 10^{6}$ (Small ALWR) person-rem with an associated annual cancer risk of $4.4 \times 10^{-5}$. If this accident occurred, this exposure would result in 2,200 cancer fatalities.

*Waste Management.* Spent nuclear fuel would be generated by the HWR, MHTGR, and ALWR, and require a new storage facility. The APT would not generate spent fuel. All technologies except the APT would generate liquid low-level waste (LLW) and require a new treatment facility. All technologies would generate solid low-level waste and require between 0.6 (APT) and 3.5 (HWR) acres per year of onsite LLW disposal area. The increase in liquid and solid mixed low-level waste generation would have minimal impact and could be handled with existing/planned facilities.

Hazardous waste generation would increase by 4 cubic yards per year (APT) to 101 cubic yards per year (MHTGR) and could be handled with existing/planned facilities. Liquid nonhazardous sanitary waste generation would increase from 425 million gallons per year (APT) to 6,310 million gallons per year (Large ALWR) and require additional treatment facilities. Solid nonhazardous sanitary waste generation would increase between 8,640 cubic yards per year (APT) and 15,000 cubic yards per year (HWR). Existing landfill design life would be reduced or require expansion. Other solid nonhazardous wastes would be recycled.

*Intersite Transport.* For all technologies, the relative risk of transporting tritium is 13 percent lower than the existing case (No Action) because the distance travelled is shorter. The potential cancer fatalities per year from transporting triated heavy water is $3.57 \times 10^{-5}$ (HWR) and $6.63 \times 10^{-6}$ (APT). There is no intersite transport of LLW for any technology. The risk of transporting new tritium for supply alone is about 2 percent greater than No Action (due to transporting new tritium to SRS).

**Pantex**

*Land Resources.* Construction and operation of a tritium supply would disturb between 173 acres (APT) and 360 acres (MHTGR). Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation. Siting any of the tritium supply technologies alone or collocated with recycling at Pantex would be consistent with site development plans. No visual impacts are expected.

*Site Infrastructure.* No roads or railroads would be required to support any technologies, but all would require new transmission lines. The power requirements would exceed the current site electrical requirement of 13 MWe by 61 MWe (MHTGR) to 565 MWe (APT).

*Air Quality and Acoustics.* Construction activities would result in exceedance of 24-hour $PM_{10}$ standard. Air pollutant concentrations would increase during operation but would be within standards. An increase in onsite noise would result from construction and operation of a tritium supply. Offsite noise impacts would be negligible.

*Water Resources.* Surface waters would not be affected by construction or operation. Groundwater use would range from 10 MGY (APT) to 35 MGY (Large ALWR) during construction. Operation water requirements would range from 43 MGY (MHTGR) to 2,656 MGY (APT). Withdrawals would adversely affect declining aquifer levels and treated wastewater discharged to playas could percolate into groundwater.

*Geology and Soils.* Construction and operation would neither affect nor be affected by geological conditions. The soil disturbed area for collocated tritium supply and recycling would range from 375 acres (APT) to 562 acres (MHTGR). Soil erosion due to wind and stormwater runoff would be minor.

*Biotic Resources.* During construction and operation, terrestrial resources would be affected by the disturbance of 375 acres (APT) to 562 acres (MHTGR) of habitat. Impacts from salt drift are possible with the APT. Playa wetlands could be degraded by discharges. Aquatic resources would not be affected. One federal-listed species, the bald eagle, could be temporarily affected during construction, and several Federal candidate or state-listed species may also be affected.

*Cultural and Paleontological Resources.* Some NRHP-eligible prehistoric and historic resources may occur within the disturbed area. Native American resources may be affected by land disturbance and audio or visual intrusions. Paleontological resources may also be affected.

*Socioeconomics.* Employment in the economic study area would increase by 4,800 (APT) to 10,900 persons (either ALWR) during peak construction. Employment during full operation would increase in the economic study area by 4,400 (APT) to 5,300 persons (HWR and MHTGR). Unemployment would decrease from 4.6 percent, the projected baseline, to between 2.2 (HWR, MHTGR, and ALWR) and 2.7 percent (APT) during peak construction and to between 2.5 (HWR and MHTGR) and 2.8 percent (APT) during full operation. Per capita income would increase by an annual average of approximately 1 percent during peak construction and full operation for HWR and APT, and less than 1 percent during peak construction and full operation for MHTGR and either ALWR.

Population and housing demand within the region of influence would increase by between 2 percent (APT) and 7 percent (ALWR) during construction and between 1 percent (APT) and 2 percent (HWR, MHTGR, ALWR) during operation.

For HWR and MHTGR technologies, total revenues and expenditures for most region of influence counties, cities, and school districts would increase by annual averages of 1 percent through 2005 then remain flat until 2010. For ALWR, total revenues and expenditures for most region-of-influence counties, cities, and school districts would increase by an annual average of 1 to 2 percent through 2005 and then decrease by 1 percent through 2010. For total revenues and expenditures for most region-of-influence counties, cities, and school districts would increase by an annual average of less than 1 percent through 2010. Between 2010 and 2020, total revenues and expenditures for all technologies would increase at annual averages of less than 1 percent.

Traffic conditions on access roads to Pantex are expected to degrade due to increased worker traffic and congestion, particularly on Farm-to-Market Road 683, the primary access route.

*Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents.* The dose to the maximally exposed member of the public from total site operation with a collocated supply and recycling facility for 1 year would range from 1.4 (APT with helium-3 target) to 4.9 (Large ALWR) mrem. The associated risk of fatal cancer from 40 years of operation would range from $2.9 \times 10^{-5}$ to $9.8 \times 10^{-5}$, respectively.

The annual 50-mile population dose from total site operation in 2030 would range from 9.2 (APT with helium-3 target) to 37 (Large ALWR) person-rem and could result in 0.18 to 0.73 fatal cancers over 40 years of operation.

The average annual dose to a site worker would range from 22 (MHTGR) to 68 (Large ALWR) mrem with the associated risk of fatal cancer from 40 years of operation ranging from $3.5 \times 10^{-4}$ to $1.1 \times 10^{-3}$, respectively. The annual dose to the total site workforce would range from 67 (MHTGR) to 210 (Large ALWR) person-rem and could result in 1.1 to 3.3 fatal cancers over 40 years of operation.

Although the noncancer adverse health effects to the public and onsite workers are within regulatory health limits, No Action cancer risks to the public and the onsite worker from emissions of hazardous chemicals exceed the accepted regulatory threshold level of $1.0 \times 10^{-6}$ annually. Potential mitigation, such as chemical substitution, can minimize these health risks.

For low to moderate consequence/high probability accidents associated with operation, the doses and risks associated with the APT are negligible. For the technology with the most severe consequences, the Large ALWR, the dose to a maximally exposed individual at the site boundary would be 3.9 rem. This dose would result in an increased likelihood of cancer fatality of $2.0 \times 10^{-3}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $2.0 \times 10^{-6}$ per year. For the population residing within 50 miles of the accident (287,000), the dose would be $1.6 \times 10^{4}$ person-rem with an associated annual cancer risk of $8.0 \times 10^{-3}$. If this accident occurred, this exposure would result in 8.0 cancer fatalities.

For high consequence/low probability accidents associated with operation, the dose to a maximally exposed individual at the site boundary is small for the APT and $1.7 \times 10^{3}$ rem for an ALWR. This dose would result in an increased likelihood of cancer fatality of 0.05. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $1.0 \times 10^{-9}$ per year. For the population residing within 50 miles of the accident (287,000), the dose would be $5.7 \times 10^{5}$

(Small ALWR) person-rem with an associated annual cancer risk of $5.7 \times 10^{-6}$. If this accident occurred, this exposure would result in 283 cancer fatalities.

*Waste Management.* Spent nuclear fuel would be generated by the HWR, MHTGR, and ALWR, and would require a new storage facility. The APT would not generate spent fuel. Generation of liquid low-level waste would increase for all technologies except the APT and require new treatment facilities. Solid low-level waste generation would increase for all technologies, requiring a new staging facility and between 16 (APT) and 92 (HWR) additional LLW shipments to NTS. Refer to the NTS alternative for the additional LLW disposal area required at NTS. The increased generation of liquid mixed low-level waste could be handled with existing/planned facilities. Solid mixed low-level waste generation would increase from 3 cubic yards per year (MHTGR) to 122 cubic yards per year (HWR). The HWR increase would require expansion of existing and planned treatment and storage facilities.

Hazardous waste generation would increase from 4 cubic yards per year (APT) to 101 cubic yards per year (MHTGR). Liquid sanitary waste generation would increase for all technologies and would require new treatment facilities. Solid sanitary waste generation would increase by 8,640 cubic yards per year (APT) to 15,000 cubic yards per year (HWR). Existing offsite landfill design life would be reduced or require expansion. Other solid nonhazardous wastes would be recycled.

*Intersite Transport.* The risk of transporting tritium is zero since there is no intersite transportation with collocating supply and recycling for all technologies at Pantex. The potential cancer fatalities per year from transporting tritiated heavy water is $3.57 \times 10^{-5}$ (HWR) and $6.63 \times 10^{-6}$ (APT). For intersite transportation of LLW, credible accidents associated with locating supply and recycling at Pantex would result in fatal cancers per year from radiological releases varying from $5.29 \times 10^{-9}$ to $2.99 \times 10^{-8}$ and from $6.68 \times 10^{-5}$ to $3.96 \times 10^{-4}$ (HWR) fatalities per year from non-radiological causes. For intersite transportation of LLW, credible accidents associated with locating a tritium supply alone at Pantex would result in fatal cancers per year from radiological releases varying from $3.25 \times 10^{-9}$ (APT) to $2.8 \times 10^{-8}$ (HWR) and from $4.30 \times 10^{-5}$ (APT) to $3.70 \times 10^{-4}$ (HWR) fatalities per year from non-radiological causes. The risk of transporting of new tritium for supply alone is about 2 percent greater than that for No Action (due to transporting new tritium to SRS).

**Savannah River Site**

*Land Resources.* Construction and operation of a tritium supply technology with the upgraded recycling facility would disturb between 200 acres (APT) and 387 acres (MHTGR). The use of an evaporative cooling tower would result in visible plumes during certain atmospheric conditions.

*Site Infrastructure.* New site infrastructure (e.g., roads and transmission lines) would be required to support all technologies. The power requirements would range from exceeding the current site electrical requirement of 130 MWe by 350 MWe (APT) to being less than the current site electrical requirement by 104 MWe (Large ALWR).

*Air Quality and Acoustics.* Construction activities would result in exceedance of 24-hour $PM_{10}$ standards. Air pollutant concentrations would increase during operation but would be within standards. An increase in onsite noise would result from construction and operation of a tritium supply. Offsite noise impacts would be negligible.

*Water Resources.* Surface water would not be required for construction. Operation surface water requirements would range from 2,665 MGY (APT) to 15,530 MGY (Large ALWR). These represent increases of between 13 and 78 percent during operation. The generation of sanitary wastes would range from 0.3 MGY (APT) to 28 MGY (Large ALWR) during construction and 22 MGY (APT) to 105 MGY (Large ALWR) during operation, respectively. Blowdown discharges to surface waters would range from 528 MGY (APT) to 6,4217 MGY (Large ALWR). Groundwater use would increase by 33 MGY during construction and 111 MGY during operation (Large ALWR), representing increases of 1 and 3.5 percent, respectively.

*Geology and Soils.* Construction and operation would neither affect nor be affected by geological conditions. The area of disturbed soil would range from 200 acres (APT) to 387 acres (MHTGR). Soil

erosion due to wind and stormwater runoff would be minor.

*Biotic Resources.* Terrestrial resources would be affected by the disturbance of between 173 acres (APT) and 360 acres (MHTGR) of habitat. Salt drift from an evaporative cooling system could impact an additional limited acreage for all technologies. Construction and operational discharges to an onsite stream could affect wetland and aquatic communities. No Federal-listed, threatened, or endangered species would be affected, but several state-listed species may be affected.

*Cultural and Paleontological Resources.* Three NRHP-eligible historic sites occur within the area that would be disturbed during construction. No historic resources would be affected. Native American resources may be affected by land disturbance and audio or visual intrusions. Paleontological resources may be affected, but impacts would be negligible.

*Socioeconomics.* Employment in the economic study area would increase between 4,200 (APT) and 10,800 (ALWR) persons during construction. Employment during operation would increase in the economic study area between 1,600 (APT) and 2,400 (HWR) persons. Unemployment would decrease from 4.8 percent, the projected baseline, to between 3.9 (HWR and ALWR) and 4.2 (APT) percent during construction and to between 4.5 (HWR) and 4.6 (APT) percent during operation. Per capita income would increase by an average of approximately 1 percent for all technologies during construction and operation.

Population and housing demand within the ROI would increase by between less than 1 percent (HWR, MHTGR, APT) and less than 3 percent (ALWR) during construction and by less than 1 percent for all technologies during operation.

Total revenues and expenditures for most ROI counties, cities, and school districts would increase by an annual average of less than 1 percent through 2020 for all technologies except for the ALWR. For the ALWR, revenues and expenditures would increase between 2 and less than 1 percent through and 2005 and then remain flat until 2010. Between 2010 and 2020, total revenues and expenditures would increase by annual averages of less than 1 percent.

Traffic conditions on access roads to SRS are expected to degrade due to increased worker traffic and congestion, particularly on South Carolina Route 125, the primary access route.

*Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents.* The dose to the maximally exposed member of the public from total site operation for 1 year would range from 2.5 (APT with a helium-3 target) to 3.9 (Large ALWR) mrem for atmospheric release. The associated risk of fatal cancer from 40 years of operation would range from $4.9 \times 10^{-5}$ to $7.8 \times 10^{-5}$, respectively. The dose from liquid releases from 1 year would range from 0.077 mrem (MHTGR and APT) to 0.26 mrem (Small ALWR). The associated risk of fatal cancers from 40 years of operation would range from $1.5 \times 10^{-6}$ to $5.3 \times 10^{-6}$

The annual 50-mile population dose from total site operation in 2030 would range from 220 (APT with the helium-3 target) to 340 (Large ATWR) person-rem and could result in 4.4 to 6.8 fatal cancers over 40 years of operation.

The average annual site dose to a site worker would range from 33 (MHTGR) to 42 (Large ALWR) mrem with the associated risk of fatal cancer ranging from $5.3 \times 10^{-4}$ to $6.7 \times 10^{-4}$, respectively, from 40 years of operation. The annual dose to the total site workforce would range from 510 (MHTGR) to 650 (Large ALWR) person-rem and could result in 8.2 to 10 fatal cancers over 40 years of operation.

Although the noncancer adverse health effects to the public are within regulatory health limits, the No Action worker effects from emission of hazardous chemicals exceed this limit. The No Action cancer risks to both the public and onsite workers exceed the generally accepted threshold of regulatory concern of $1 \times 10^{-6}$.

For low to moderate consequence/high probability accidents associated with operation, the dose to a maximally exposed individual at the site boundary would be small for the APT and 14 rem for the Large ALWR. This dose would result in an increased likelihood of cancer fatality of $7.1 \times 10^{-3}$. Given an

accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $7.1 \times 10^{-6}$ per year. For the population residing within 50 miles of the accident (773,000), the dose would be $4.6 \times 10^{5}$ (Large ALWR) person-rem with an associated annual cancer risk of 0.23. If this accident occurred, this exposure would result in 230 cancer fatalities.

For high consequence/low probability accidents associated with operation, the dose to a maximally exposed individual at the site boundary would be small for the APT and 174 rem for an ALWR. This dose would result in an increased likelihood of cancer fatality of $5.3 \times 10^{-3}$. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $1.1 \times 10^{-10}$ per year. For the population residing within 50 miles of the accident (773,000), the dose would be $2.0 \times 10^{6}$ (ALWR) person-rem with an associated cancer risk of $2.0 \times 10^{-5}$. If this accident occurred, this exposure would result in 984 cancer fatalities.

*Waste Management.* Spent nuclear fuel would be generated by the HWR, MHTGR, and ALWR, and require a new storage facility. The APT would not generate spent fuel. All technologies except the APT would generate liquid low-level waste and require a new treatment facility. All technologies would generate solid low-level waste and require between 1 (APT) and 12 (HWR) acres per year of onsite LLW disposal area. No additional liquid mixed low-level waste would be generated from the tritium supply technologies. The generation of solid mixed low-level waste would increase by 1 cubic yards per year (MHTGR) to 120 cubic yards per year (HWR). The HWR may require new or expanded treatment and storage facilities.

Hazardous waste generation would increase by 3 cubic yards per year (APT) to 100 cubic yards per year (MHTGR) and would require additional storage facilities except for APT. Liquid nonhazardous sanitary waste would increase by 401 million gallons per year (APT) to 6,290 million gallons per year (Large ALWR) and require additional treatment facilities. Solid nonhazardous sanitary waste generation would increase by 1,240 cubic yards per year (APT) to 7,600 cubic yards per year (HWR). Existing landfill design life would be reduced or require expansion. Other solid nonhazardous wastes would be recycled.

*Intersite Transport.* The risk associated with transportation of tritium when collocating supply and recycling is the same as No Action for all supply technologies. There is no intersite transport of LLW for any supply technology.

## MULTIPURPOSE ("TRIPLE PLAY") REACTOR

The Department's Office of Fissile Materials Disposition is preparing a PEIS addressing the issue of how to dispose of plutonium that is excess to nuclear weapons requirements. Among the alternatives expected to be analyzed in the Storage and Disposition of Weapons-Usable Fissile Materials PEIS is the use of plutonium as a fuel in existing, modified, or new nuclear reactors.

The nuclear reactors evaluated for tritium production in the Tritium Supply and Recycling PEIS utilize uranium as the fuel source, and the analysis in this PEIS is based on that design. Nonetheless, it is technically feasible to also use plutonium or plutonium-uranium oxide (mixed-oxide) fuel for a tritium production reactor. Congress and commercial entities have expressed interest in developing a multipurpose ("triple play") reactor that could produce tritium, "burn" plutonium, and generate revenues through the sale of electric power. Only the ALWR and MHTGR would be capable of performing the triple play missions; the potential environmental impacts from these triple play reactors are summarized below.

**Advanced Light Water Reactor.** If an ALWR were used to burn plutonium, the major contributions to potential environmental impacts would be from a new plutonium pit disassembly/conversion/mixed-oxide fuel fabrication facility. Such a facility could disturb up to 129 acres of land, and require a peak construction force of 550 during the peak year of the 6 year construction period.

During operation, this facility would require approximately 10 percent as much water as a large ALWR at a dry site, and would employ as many workers as the ALWR. Radiological exposures to workers during normal operation would be kept as low as reasonably achievable, and would not be expected to exceed 50 mrem per worker per year. If all 650 workers were exposed to such a dose, a highly conservative assumption, 0.52 latent cancer fatalities (less than

one) would be expected over the 40 year operation life of the facility. The goal for the facility for public radiation exposure would be not to exceed 1.0 mrem effective dose equivalent per year.

Safety analysis reports have not been prepared for this facility. However, bounding accident scenarios have been identified from safety analysis reports for similar plants. Criticality accidents, explosions, and fires could occur in such a facility, and release radiation to the environment. Any postulated releases to the environment would increase the risk and number of latent cancers to a surrounding population.

Using a mixed-oxide fuel in an ALWR would have no major effect on reactor operations, and therefore, impacts would not be expected to change significantly from those associated with utilizing a uranium fueled reactor. This is based on a study conducted by the NRC, the *Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed-Oxide Fuel in Light Water Reactors.*

**Modular High Temperature Gas-Cooled Reactor.** To burn plutonium in a modular gas-cooled reactor, a plutonium pit disassembly/conversion/plutonium-oxide fuel fabrication facility would also be needed, and the environmental impacts from such a facility are expected to be approximately the same as those described for the facility to support a multipurpose ALWR. In a plutonium-fueled gas-cooled reactor, however, tritium production decreases significantly. Thus, twice as many reactor modules would be necessary in order to produce the steady-state tritium requirements. This doubling of reactor modules would be the major contributor to potential environmental impacts for this scenario.

Overall, building twice as many reactor modules could double most environmental impacts. Some construction impacts (land distributed, construction duration, and peak construction workforce) might be less than double because of economies of scale and shared support infrastructure. Depending upon the particular site, some impacts could be significant.

During operation of twice as many reactor modules, water requirements could increase by 80 percent. This could cause adverse impacts to groundwater at dry sites. The expected workforce increase would approximately double any socioeconomic impacts and radiation doses to workers. Radiation exposure to the public from normal operation might also double. Due to the lack of source term data and accident behavior for a plutonium-fueled gas-cooled reactor, postulated accidents and resulting radiological impacts cannot be determined at this time. Spent fuel generation would also double with the addition of twice as many reactor modules.

## AGENCY PREFERRED ALTERNATIVE

The Council on Environmental Quality (CEQ) regulations require that an agency identify its preferred alternative, if one or more exists, in the Draft Environmental Impact Statement (40 CFR 1502.14(e)). The preferred alternative is the alternative that the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. Consequently, to identify a preferred alternative, the Department has developed information on potential environmental impacts, and is continuing to develop costs, technical risks, and schedule risks for the alternatives under consideration. For this draft PEIS, no preferred alternatives exist for (1) tritium supply technology; (2) tritium supply site; or (3) tritium recycling site.

The final PEIS will include any preferred alternatives. However, the Department may choose to identify a preferred alternative prior to publication of the final PEIS. The Record of Decision will describe the Department's decision for tritium supply and recycling.

# CHAPTER 1

# Chapter 1

# CHAPTER 1: INTRODUCTION

***Chapter 1 begins with a description of the Department of Energy's Tritium Supply and Recycling Proposal. This chapter also describes the Department of Energy's compliance with the National Environmental Policy Act for tritium supply and recycling, time periods considered in this analysis, and other Department of Energy National Environmental Policy Act documents that are currently being prepared or are in the planning phase. Chapter 1 includes discussions of the background of the Nuclear Weapons Complex Reconfiguration Program, recent changes affecting the Reconfiguration Program, the specific alternatives analyzed in this document, and the scoping process used to obtain public input on the issues to be addressed in this study. The chapter concludes with the organization of the document.***

## 1.1 THE TRITIUM SUPPLY AND RECYCLING PROPOSAL

The Department of Energy (DOE) proposes to provide tritium supply and recycling facilities for the Nation's Nuclear Weapons Complex (Complex). Tritium, a man-made radioactive isotope of hydrogen, is an essential component of every warhead in the current and projected U.S. nuclear weapons stockpile. These warheads depend on tritium to perform as designed. Tritium decays at 5.5 percent per year and must be replaced periodically as long as the Nation relies on a nuclear deterrent. Currently, there is no capability to produce tritium within the Complex, yet projections require that new tritium be available by approximately 2011. This *Tritium Supply and Recycling Programmatic Environmental Impact Statement* (PEIS) evaluates the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at each of five candidate sites: the Idaho National Engineering Laboratory (INEL), Nevada Test Site (NTS), Oak Ridge Reservation (ORR), the Pantex Plant, and the Savannah River Site (SRS). This PEIS assesses the environmental impacts of all reasonable alternatives discussed below, including No Action.

Tritium supply deals with the production of new tritium in either a reactor or an accelerator by irradiating target materials with neutrons and the subsequent extraction of the tritium in pure form for its use in nuclear weapons. Tritium recycling consists of recovering residual tritium from weapons components, purifying it, and refilling weapons components with both recovered and new tritium when it becomes available.

Under No Action, DOE would not establish a new tritium supply capability. The current inventory of tritium would decay and DOE would not meet stockpile requirements of tritium. This would be contrary to DOE's mission as specified by the *Atomic Energy Act* of 1954, as amended. The current DOE missions assumed to continue under No Action are listed in section 3.3 for each candidate site.

Alternatives for new tritium supply and recycling facilities consist of four different tritium supply technologies and five locations. The four technologies proposed to provide a new supply of tritium are Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), Advanced Light Water Reactor (ALWR), and Accelerator Production of Tritium (APT). Both Large (1,300 MWe) and Small (600 MWe) options for the ALWR are evaluated as well as a phased approach for the APT. This PEIS also includes an analysis of the MHTGR and ALWR technologies for tritium production along with plutonium disposition and steam/electricity production. Also analyzed is the use of an existing commercial light water reactor that would be purchased and converted for tritium production.

Additionally, this Tritium Supply and Recycling PEIS includes an assessment of the environmental and institutional impacts associated with using one or more commercial light water reactors for tritium production as a contingency in the event of a national emergency. This contingency option would permit the commercial reactor to continue normal electricity generation. Specific commercial reactors are not identified in this PEIS. Currently DOE has no preferred alternative for tritium supply and recycling.

This PEIS also addresses the environmental impacts of an ALWR or modular gas-cooled reactor used as a multipurpose reactor. A multipurpose ("triple play") reactor is defined as one capable of producing tritium, "burning" plutonium, and generating revenues through the sale of electric power.

## 1.2 Compliance with the *National Environmental Policy Act* for Tritium Supply and Recycling

DOE intends to comply with the *National Environmental Policy Act* (NEPA) for tritium supply and recycling in two phases. The first phase includes this PEIS and subsequent Record of Decision (ROD). The second phase includes site-specific NEPA documents that would be tiered from this PEIS. Decisions will be based on relevant factors including economic and technical considerations, DOE statutory mission requirements, and environmental impacts. As required by NEPA, this PEIS provides environmental analyses to support the ROD. In addition to the analysis in this PEIS, engineering studies will provide cost, schedule, and technical feasibility analyses for consideration in the ROD. These studies will be presented in a Technical Reference Report.

The programmatic decisions needed to plan for tritium supply and recycling focus on siting and technology. Project-level decisions would focus on construction and operation impacts and would be made after subsequent site-specific tiered NEPA reviews are completed.

The ROD may include the following programmatic decisions:

- Whether to build new tritium supply and new or upgraded tritium recycling facilities;
- Where to locate tritium supply and recycling facilities;
- Which technology to employ for tritium supply.

The ROD will not include decisions regarding cleanup or waste management at phased-out facilities; the ultimate disposition of these facilities; or the long-term storage, treatment, and ultimate disposal of some wastes and spent fuel. These activities are being covered by separate NEPA documents. However, this PEIS does address the waste management implications of the alternatives considered to the extent needed to support programmatic decisions regarding the sites and technologies analyzed.

The design goals of any new processes and facilities will include achieving, to the greatest extent practicable, pollution prevention and waste minimization. In addition, one of the design goals is to maximize the ease of ultimate decontamination and decommissioning (D&D). The ROD will identify the waste management implications on facility design for each of the alternatives and any future actions (including D&D).

In accordance with the Council on Environental Quality (CEQ) regulations for implementing NEPA (40 CFR 1500-1508), DOE intends to "tier" site-specific environmental analyses from this PEIS for specific project proposals; hence, subsequent proposed actions regarding specific facilities and their impacts are not analyzed in this PEIS. The "tiered" analyses and their related decision documents would be completed before project construction could begin.

## 1.3 Time Period Considered in Analysis

The Tritium Supply and Recycling Proposal would proceed in three phases. The first phase involves preparing information to support programmatic decisions on siting and technology. This includes preparing this PEIS and the associated ROD. During the second phase, DOE would develop detailed designs and meet project-specific NEPA requirements to implement the programmatic decisions. The third phase would involve constructing, testing, and certifying the selected tritium supply and recycling facilities, leading to full operation. Present planning, depending on funding levels, requires the tritium facilities to be fully operational by the year 2010 with new tritium available for use approximately 1 year later.

Following this PEIS, DOE would develop a schedule for implementing the ROD decision. The schedule would be subject to change and include reassessments required by congressional authorizations and

appropriations. Although the individual schedules of any activities or projects may overlap, the current uncertainty associated with any given activity or project requires that assumptions be made regarding the time periods used in this PEIS analysis.

Because of the uncertainties associated with the scheduling of the second and third phases, this PEIS assumes an environmental baseline period for construction between 1999 and 2009, and an operational period of 40 years beginning in approximately 2010. Although the design life of the tritium supply and recycling facilities has not yet been determined by engineering studies, the assumption of an operational period of approximately 40 years is consistent with the operating periods used in prior DOE NEPA documents for similar new facilities. Project-level tiered NEPA documents would identify in detail the specific construction and operational periods for each project implemented.

## 1.4 Background

The Complex is a set of interrelated facilities supporting the research, development, design, manufacture, testing, and maintenance of the Nation's nuclear weapons and the subsequent dismantlement of retired weapons. In the past, Complex facilities have produced large numbers of nuclear weapons from new components. However, due to substantial reductions in the requirements for nuclear weapons, the Complex's current focus has shifted to weapon dismantlement, recycling nuclear materials used in building nuclear weapons, storing strategic materials for future use, and conducting surveillance and maintenance activities to ensure the continued reliability and safety of the weapons in the Nation's stockpile. The Complex currently consists of 11 sites located in 10 states, as shown in figure 1.4–1. Hanford and INEL are currently not part of the Complex.

### 1.4.1 Defense Program Mission

As a matter of national policy, Congress declared in the *Atomic Energy Act* of 1954 that the development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security. In addition, Congress assigned the nuclear weapons manufacturing and stockpile sustainment role to the Atomic Energy Commission. Today that role resides with DOE.

The size of the Nation's nuclear weapons stockpile is determined on a year-to-year basis. The Secretaries of Defense and Energy, in coordination with the Nuclear Weapons Council, jointly sign and submit the Nuclear Weapons Stockpile Memorandum. The Nuclear Weapons Stockpile Memorandum transmits the *Nuclear Weapons Stockpile Plan* to the President for final approval. The Plan covers an 11-year period, specifies the types and quantities of weapons required, and sets limits on the size and nature of stockpile changes that can be made without additional approval from the President. As such, the *Nuclear Weapons Stockpile Plan* is the basis for all weapons planning in DOE. The President takes the Nuclear Weapons Stockpile Memorandum under advisement each year and issues a National Security Directive to DOE and the Department of Defense (DOD) approving the *Nuclear Weapons Stockpile Plan* for implementation. Figure 1.4.1–1 depicts the Nuclear Weapons Stockpile Memorandum process.

### 1.4.2 Evolution of the Tritium Supply and Recycling Proposal

The Tritium Supply and Recycling Proposal has evolved from the original Reconfiguration Program. The original reconfiguration concept, changes over time, and reasons for these changes are discussed in detail in the revised Implementation Plan (IP) for the Tritium Supply and Recycling PEIS and are outlined briefly below. A detailed discussion of the current tritium supply proposal follows. Figure 1.4.2–1 depicts the evolution of the Reconfiguration Program and the Tritium Supply and Recycling Proposal.

The Complex is administered by the DOE Office of the Assistant Secretary for Defense Programs (DP) and consists of government-owned, contractor-operated facilities located at 11 sites around the country. Many of the facilities in the Complex were constructed more than four decades ago and will need repairs, upgrades, and/or modifications to meet current environment, safety, and health (ES&H) requirements. Additionally, many of the facilities were sized to meet stockpile requirements substantially larger and more diverse than current requirements or those expected in the future.

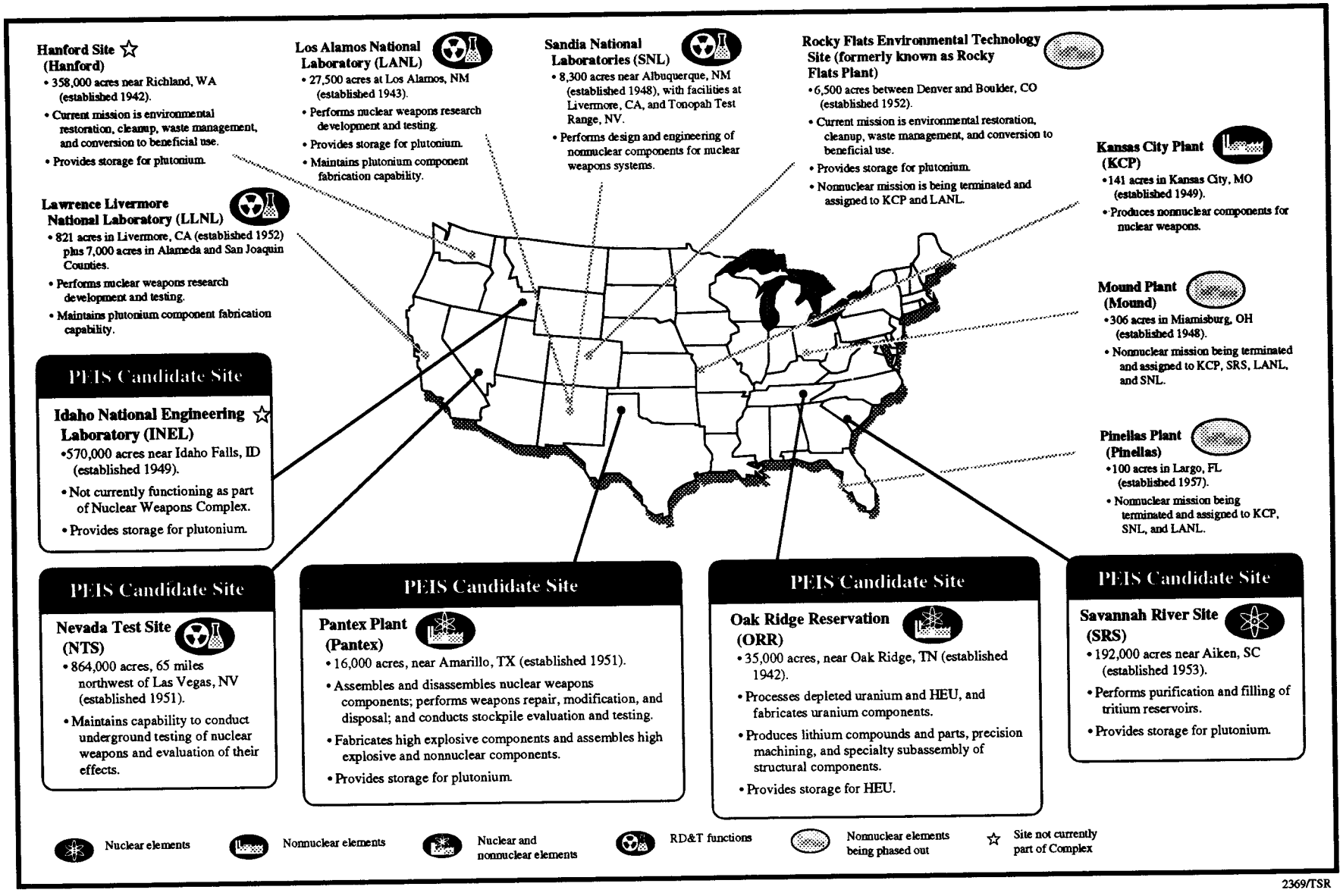


**FIGURE 1.4–1.**—*Nuclear Weapons Complex Sites.*

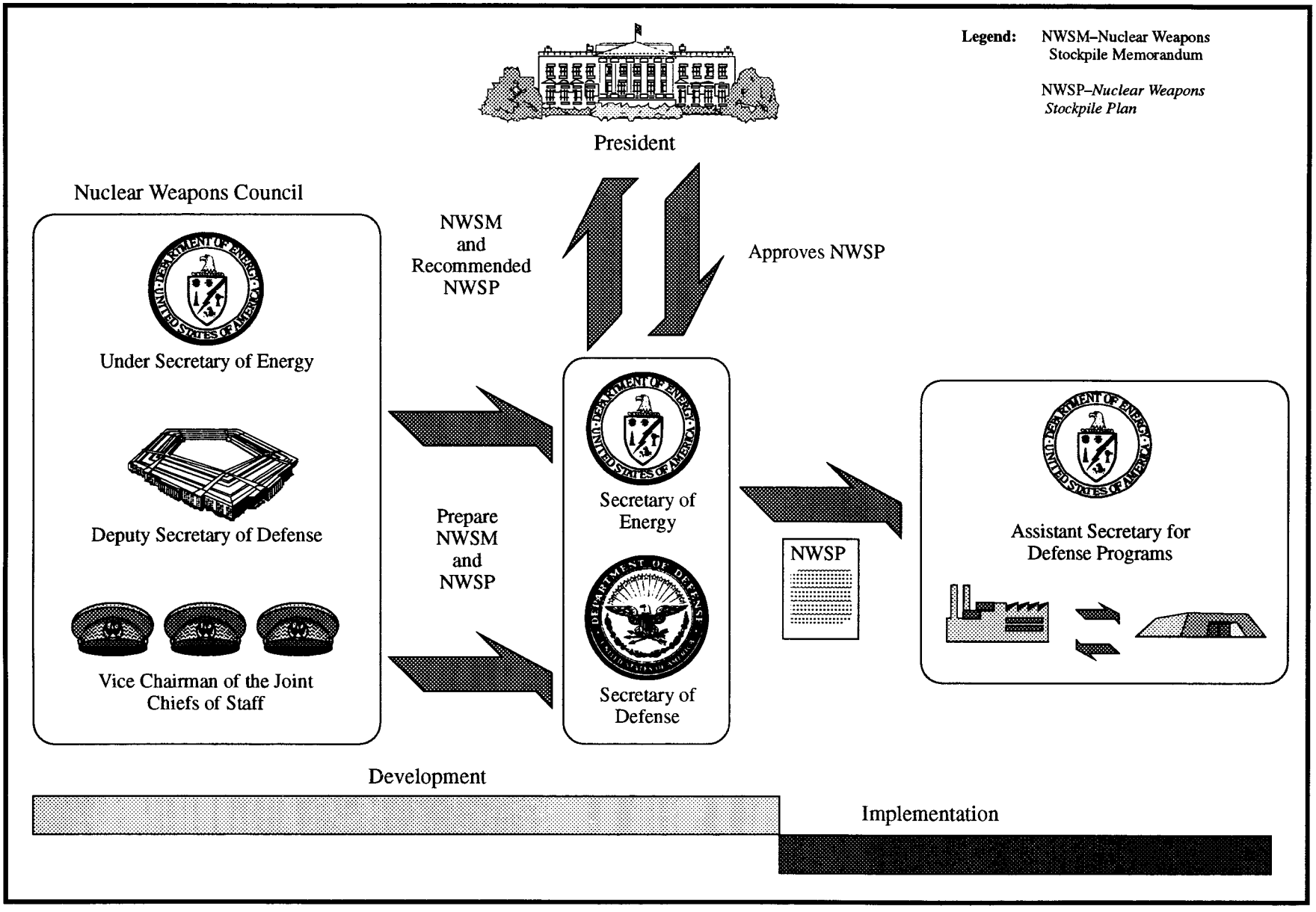


FIGURE 1.4.1–1.—*Nuclear Weapons Stockpile Memorandum Process.*

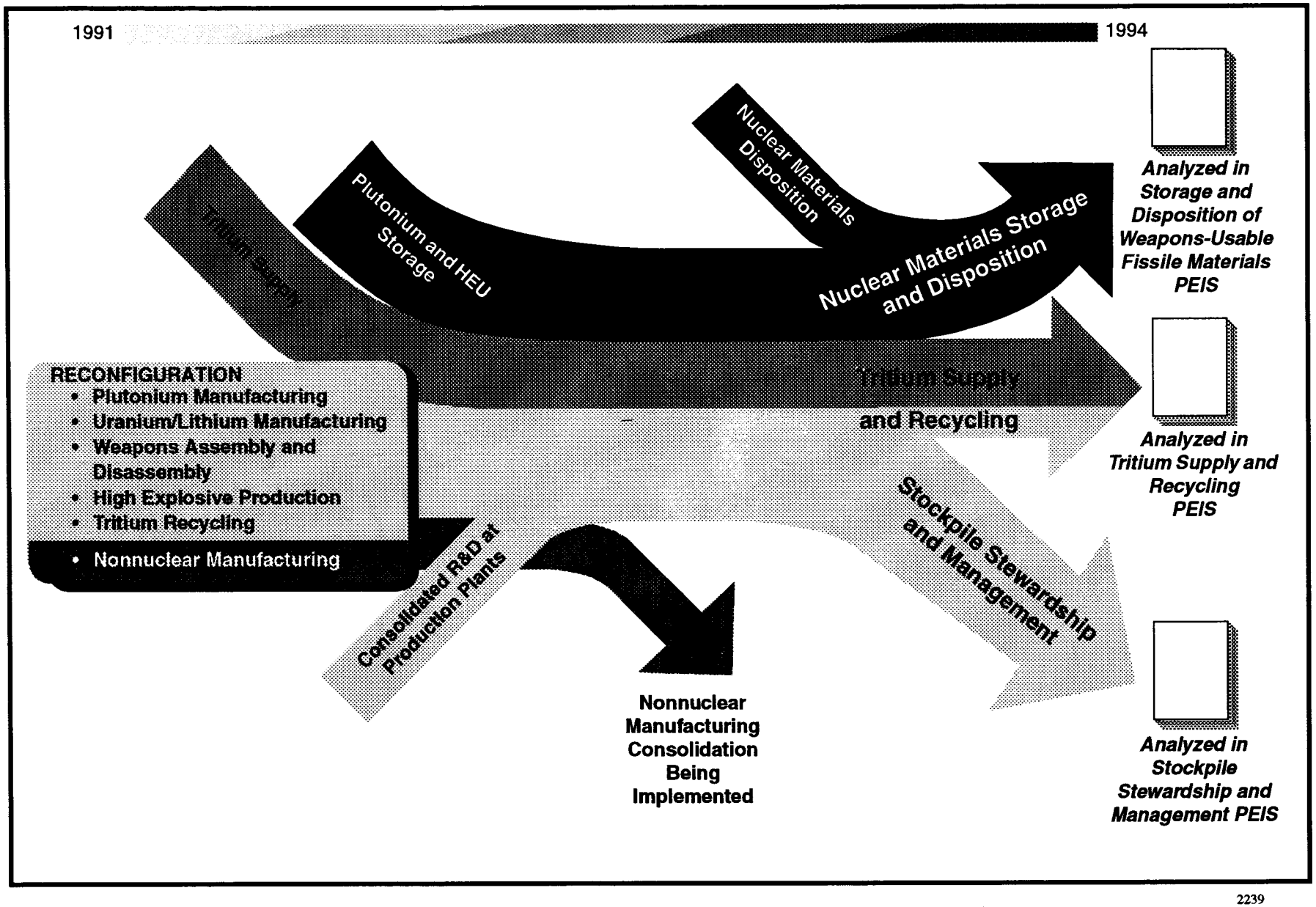


FIGURE 1.4.2–1.—*Evolution of the Reconfiguration Program, 1991–1994.*

Congress recognized that a comprehensive rather than a piecemeal approach was needed to address problems arising from an aging Complex; Congress directed in the *National Defense Authorization Act* for fiscal years 1988 to 1989 (Public Law 100-180) that a study be conducted and a plan prepared by the President to modernize the Complex. The product of this study, titled the *U.S. Department of Energy Nuclear Weapons Complex Modernization Report* (December 1988), was submitted to Congress on January 12, 1989. The report called for extensive modernization of facilities over a 15- to 20- year period.

In September 1989, DOE established a Modernization Review Committee to review the assumptions and recommendations contained in the Modernization Report. Chaired by the Under Secretary, the committee was directed to reexamine the modernization issue and develop a program to address the issues already identified. In January 1991, this committee issued a report summarizing their findings. This study, entitled the *Nuclear Weapons Complex Reconfiguration Study* (DOE/DP-0083), outlined a proposed future Complex and charted the course necessary to achieve the goal of modernization. It included a discussion of potential configurations of the future Complex, transitional activities, activities necessary for compliance with NEPA, and recommendations to improve management of the Complex.

On February 11, 1991, DOE published a Notice of Intent (NOI) in the *Federal Register* (56 FR 5590) to prepare a PEIS, pursuant to NEPA, on reconfiguring the Complex. The NOI proposed to analyze the environmental impacts of the alternatives presented in the *Nuclear Weapons Complex Reconfiguration Study.*

In September 1991, the President made the first of three announcements involving significant reductions in the nuclear weapons stockpile. As a consequence of stockpile reductions, decreased demand for tritium, and an increased supply of recovered tritium from dismantled weapons, the urgency to develop a new tritium supply source was eased. Consequently, DOE announced on November 1, 1991, its decision to incorporate the environmental impact analysis for the DOE New Production Reactor Capacity Proposal into the Reconfiguration PEIS and include the new production reactor siting and technology decisions in the Reconfiguration ROD. This action added the programmatic analysis of tritium supply capacity into the Reconfiguration PEIS. The New Production Reactor Program was evaluating the potential environmental impacts of siting either an HWR, Light Water Reactor (LWR), or MHTGR at Hanford, INEL, or SRS. It also considered the No Action alternative of continuing tritium production at the K- or L-Reactor at SRS. The New Production Reactor Program, which was subsequently cancelled, provided engineering and design information for use in the Reconfiguration PEIS.

In December 1991, the Secretary decided to separate the nonnuclear consolidation analysis, originally part of the Reconfiguration PEIS, from the nuclear analysis. The reasons for this included the potential for near-term, significant cost savings and the fact that nonnuclear consolidation decisions would neither affect nor be affected by the Reconfiguration decisions.

On January 27, 1992, DOE provided the public notice of its plans to prepare an environmental assessment (EA) for its proposal to consolidate certain nonnuclear facilities in the Complex (57 FR 3046). These facilities manufacture nonnuclear parts required for nuclear weapons and perform regular testing of individual components. The Final EA was published on June 31, 1993 and a Finding of No Significant Impact was published in the *Federal Register* (58 FR 176) on September 14, 1993. Shortly thereafter, DOE began implementing the Nonnuclear Manufacturing Consolidation Program. This action will terminate the Complex mission at Mound, Pinellas, and Rocky Flats Environmental Technology Site (formerly known as Rocky Flats Plant). Activities previously performed at these facilities will be consolidated primarily at the Kansas City Plant, with the remaining activities being relocated to SRS, Los Alamos National Laboratory, and Sandia National Laboratories, New Mexico.

Further stockpile reductions, including the Strategic Arms Reduction Treaty (START) II, resulted in DOE reevaluating the Reconfiguration Program. On July 23, 1993, a revised NOI for the Reconfiguration PEIS was published in the *Federal Register* (58 FR 39528). This NOI described DOE's vision of a much smaller and more highly integrated Complex than originally planned. Additionally, long-term storage

options for plutonium and highly enriched uranium were added to this PEIS analysis. In this regard, the alternative of consolidated long-term storage facilities for plutonium and highly enriched uranium was added, since weapons retirements were occurring in larger numbers and at a faster rate than was ever envisioned. In addition, the components were not being recycled into new weapons, as they had been in the past. This situation placed increased importance on the stewardship of existing special nuclear materials.

The Hanford Site was dropped and NTS was added as a candidate site for future weapons complex missions. DOE also added alternatives to consider upgrades and/or modifications to existing facilities to meet the reduced workload requirements while still complying with ES&H regulations. Upgrades and/or modifications were considered in addition to new facilities. The new facilities were downsized from previous plans and the option of integrating research, development, and testing activities into the plant designs and consideration of accelerator technology for the production of tritium possible were also added.

In September and October 1993, DOE held a series of public scoping meetings following the issuance of the revised NOI. During the public scoping period, many members of the public questioned why DOE was proceeding to analyze new weapons facilities in general, and new component fabrication facilities in particular, given the lack of requirements for new weapons and an otherwise limited workload. There appeared to be a perception among many members of the public that the evaluation of new facilities in the PEIS indicated an intention to construct these facilities in a predetermined time frame. In addition, many members of the public commented that DOE should address alternatives for the disposition of plutonium that is excess to strategic needs, in addition to alternatives for long-term storage.

DOE has concluded that the framework described in the *Nuclear Weapons Complex Reconfiguration Study* does not exist today. Contributing factors to this conclusion include public comments at the September and October 1993 PEIS scoping meetings; the fact that no new nuclear weapons production is required for the foreseeable future; budget constraints; and DOE's decision to prepare a PEIS on storage and disposition of weapons-usable fissile materials (59 FR 31985). As a result of these changed circumstances, DOE decided to separate the Reconfiguration PEIS into two PEISs: (1) the Tritium Supply and Recycling PEIS to address the need for tritium and (2) a Stockpile Stewardship and Management PEIS to address the rest of the Complex (59 FR 54175).

## 1.5 Other *National Environmental Policy Act* Reviews

The Tritium Supply and Recycling PEIS has been coordinated with other NEPA documents. Programmatic NEPA documents currently in progress or in the planning phase are discussed in the following sections.

### 1.5.1 Stockpile Stewardship and Management Programmatic Environmental Impact Statement

The Stockpile Stewardship and Management PEIS will be prepared once the Department formulates and defines a new stockpile stewardship and management proposal. Stockpile stewardship includes activities required to maintain a high level of confidence in the safety, reliability, and performance of nuclear weapons in the absence of underground testing, and to be prepared to test weapons if directed by the President. Stockpile management activities include maintenance, evaluation, repair, or replacement of weapons in the existing stockpile.

DOE is currently reviewing its nuclear weapons complex stockpile stewardship and management activities in light of current and projected stockpile requirements. A public meeting is being planned for early 1995 to receive comments on how to conduct the scoping process for the Stockpile Stewardship and Management PEIS, and to have preliminary discussions on potential alternatives. This will be followed by public scoping meetings in the summer of 1995.

### 1.5.2 Waste Management Programmatic Environmental Impact Statement

The Waste Management PEIS, which is currently being prepared, is analyzing alternatives for managing the safe disposal of radioactive, hazardous, and mixed (i.e. radioactive and hazardous) wastes.

When completed, the PEIS will support DOE decisions on the management of processes or facilities for treatment, storage, or disposal of radioactive, hazardous, or mixed wastes. An NOI to prepare the Waste Management PEIS was published in the *Federal Register* on October 22, 1990 (55 FR 42633). The results of the scoping process, which included public scoping meetings and public workshops on the Draft IP, and a discussion of alternatives are documented in the Final IP for the Waste Management PEIS (DOE/EIS-0200) published in January 1994.

This PEIS addresses management of wastes and the facilities needed to accomplish an interim waste management mission in a manner that is consistent with future Environmental Management Program decisions. Additionally, this PEIS discusses ways to minimize waste generation during operation. The Waste Management PEIS is also addressing longer term management of wastes, including wastes that may be generated from long-term tritium supply and recycling activities. Many technologies required for the ultimate treatment and disposal of DOE wastes must still be developed. This is an even longer term effort and will follow decisions based on the Waste Management PEIS. Preparation of the PEISs has been closely coordinated to ensure that any cross-cutting issues are fully considered in the decision-making process.

### 1.5.3 Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement

The Storage and Disposition of Weapons-Usable Fissile Materials PEIS, which is currently being prepared, is analyzing alternatives for the long-term storage of weapons-usable fissile materials, and the disposition of weapons-usable fissile materials declared surplus to national defense needs by the President. One of the alternatives being analyzed would utilize surplus plutonium as fuel in existing, modified, or new nuclear reactors. The tritium supply technologies analyzed in this PEIS have the potential to utilize surplus plutonium. A discussion of disposing of plutonium in a new tritium supply facility is discussed in appendix A.3. An NOI to prepare the Storage and Disposition of Weapons-Usable Fissile Materials PEIS was published in the *Federal Register* on June 21, 1994 (59 FR 31985). The results of the scoping process, which included the public scoping workshops announced in the *Federal Register* on July 18, 1994 (59 FR 36430), and a discussion of the alternatives to be analyzed will be documented in the IP for the Storage and Disposition of Weapons-Usable Fissile Materials PEIS.

### 1.5.4 Programmatic Spent Nuclear Fuel Management Environmental Impact Statement

The Programmatic Spent Nuclear Fuel Management EIS, which is currently being prepared, is analyzing alternatives for managing DOE spent nuclear fuel on a national level. The alternatives analyzed in the Draft EIS include the Hanford Site, INEL, NTS, ORR, and SRS as potential sites for the management of all DOE spent nuclear fuel. Except for Hanford, these sites are also being considered as candidates for tritium supply technologies and recycling facilities in the Tritium Supply and Recycling PEIS. A Notice of Availability for the Draft Programmatic Spent Nuclear Fuel Management EIS and Announcement of Public Hearings was published in the *Federal Register* on June 24, 1994 (59 FR 32688). A record of the public comments received on the Draft Programmatic Spent Nuclear Fuel Management EIS, DOE's responses to the comments, and any revision to the draft will be included in the Final EIS, which is scheduled to be available no later than April 30, 1995.

## 1.6 Program Changes

A number of significant program changes have occurred since publication of the *Nuclear Weapons Complex Reconfiguration Study* and the original NOI (56 FR 5590) to prepare this PEIS. These changes include the following:

**Long-Term Storage for Special Nuclear Materials.** Since the original Reconfiguration Proposal was published, a significant number of weapons have been and will continue to be retired from the Nation's active nuclear weapons stockpile. Previously, the stockpile reductions mandated that relatively few weapons would be retired without replacement. Therefore, when the original NOI and IP were prepared, the long-term storage of these materials was not a contemplated mission requirement since disassembled components would be recycled into

new weapons. Presently, DOE does not have a consolidated facility to store either plutonium or HEU. Therefore, DOE is preparing the Surplus Fissile Materials PEIS to address long-term storage of these materials.

**Siting Alternatives for Weapons Functions.** In the original February 1992 IP for the Reconfiguration PEIS, Hanford, INEL, ORR, Pantex, and SRS were identified as reasonable alternative sites for the proposed reconfigured facilities. However, based upon reevaluation of the original proposal, DOE added NTS to this PEIS as a potential site for the tritium supply and recycling facilities. NTS is a large, remote site that meets the minimum qualification criteria (56 FR 5595) against which the other sites were evaluated, and it has a significant existing infrastructure that could accommodate these functions. Additionally, Hanford was eliminated as a candidate site for the future Complex because nuclear weapons production functions at that site have been terminated. The site is now dedicated to the DOE Office of the Assistant Secretary for Environmental Management (EM) activities.

**Tritium Production.** The New Production Reactor EIS was intended to assess Hanford, INEL, and SRS as alternative sites for new tritium supply. Based on the decision to eliminate Hanford, however, new tritium supply will instead be considered for NTS. In addition, given the much smaller capacity needed to satisfy the tritium production requirements than originally contemplated, DOE concluded that ORR and Pantex constitute reasonable candidate sites for tritium supply and recycling facilities. Therefore, ORR and Pantex were added to the list of candidate sites for these facilities in this PEIS.

**Weapons Complex Mission Changes**. Since the publication of the original NOI, there have been changes within the Complex that have affected the No Action alternative in this PEIS. Some functions that were previously performed at particular sites can no longer be performed in existing facilities at those sites. More specifically, the K-Reactor at SRS has been placed in cold standby with no planned provision for restart. This has effectively eliminated DOE's ability to produce tritium to support the projected stockpile requirements. Consequently, at some point the nuclear deterrent capability of the Nation would either be lost or based upon weapons which would be significantly different from those in the current stockpile. This capability would not meet present mission requirements.

## 1.7 THE SCOPING PROCESS

Scoping for the PEIS consisted of both internal DOE scoping and external public scoping. Internal DOE scoping began with expert working groups that produced the *U.S. Department of Energy Nuclear Weapons Modernization Report* (December 1988) and the *Nuclear Weapons Complex Reconfiguration Study.* External scoping began after DOE completed the *Nuclear Weapons Complex Reconfiguration Study* and published an NOI in the *Federal Register* (56 FR 5590) on February 11, 1991. The original NOI public scoping phase, which included public meetings at potentially affected sites, ended September 30, 1991. The scoping process and results of the first NOI are discussed in detail in the February 1992 IP (DOE/EIS-0161IP). A revised NOI (58 FR 39528) was published on July 23, 1993, and additional public scoping was conducted through October 29, 1993. A notice (59 FR 54175) was published in the *Federal Register* on October 28, 1994, inviting public comment on the proposal to separate the Reconfiguration PEIS into two separate PEISs.

As shown in figure 1.7–1, public scoping meetings for the revised NOI were conducted at 12 locations around the country to allow interested parties to present spoken comments and other information. All comments received through public scoping were organized and reviewed for consideration during the preparation of the revised IP and this PEIS. An extensive summary of all comments received during the public scoping process, along with the planned scope and content of this PEIS, was published in the revised IP (DOE/EIS-0161IPREV).

During the PEIS scoping process, DOE received a total of 74,804 comments from 38,533 members of the public, representatives of interest groups, and from Federal, state, and local officials. Of these, 2,418 were spoken and recorded at public scoping meetings, and 72,386 were written and submitted at scoping meetings or received by mail. The total number of comments includes 63,363 comments received from 34,183 preprinted postcards, form letters, or petition campaigns. A review of the

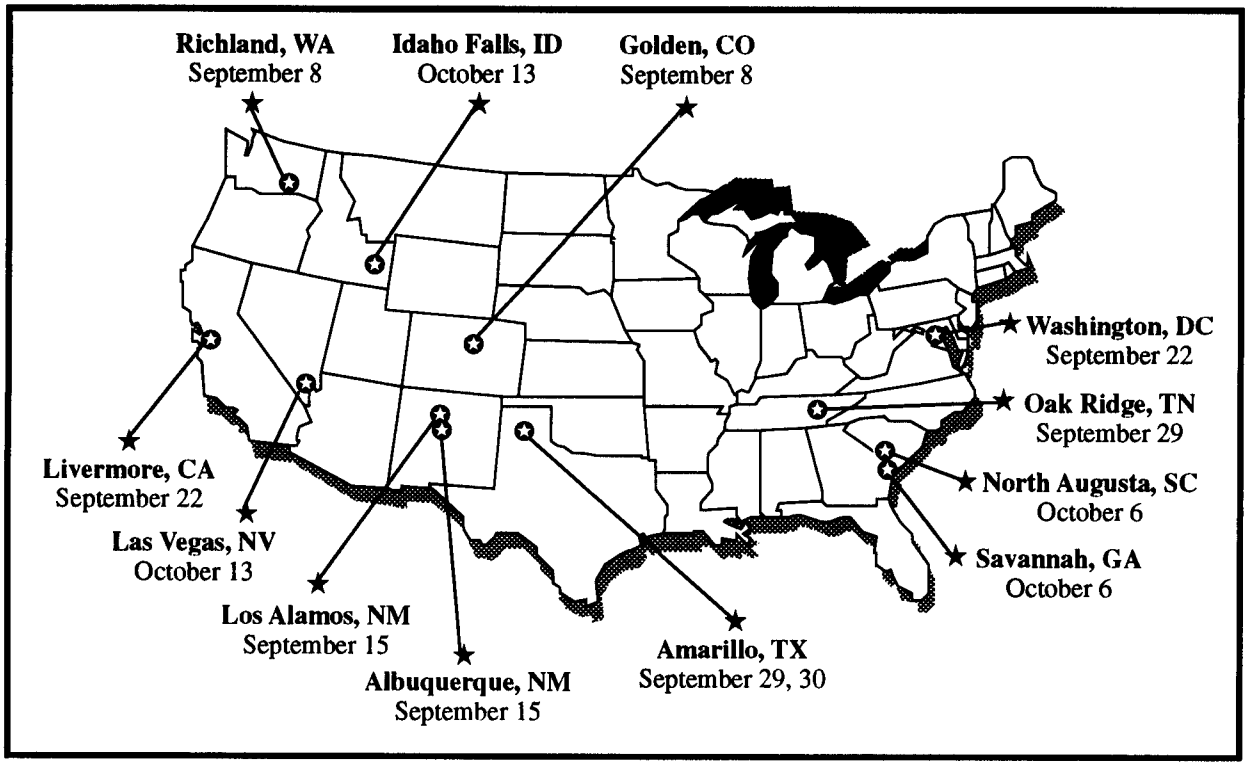


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**FIGURE 1.7–1.**—*Scoping Meeting Locations and Dates, 1993.*

comments received was conducted to identify significant issues to be analyzed in the PEIS.

Major issues identified through both internal DOE scoping and public scoping are addressed in this PEIS by analyses at each DOE site in the following areas:

- Land resources, including land use and visual resources.
- Site infrastructure.
- Air quality and acoustics.
- Water resources, including surface water and groundwater.
- Geology and soils.
- Biotic resources, including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.
- Cultural and paleontological resources, including prehistoric resources, historic resources, Native American resources, and paleontological resources.
- Socioeconomics, including employment and local economy, population, housing, community or local government public finances, and local transportation.
- Radiological and hazardous chemical impacts during normal operations and accidents.
- Waste management.

In addition to analyses conducted at each site, this PEIS addresses monitoring and mitigation; intersite transportation of nuclear materials and other hazardous substances; unavoidable impacts and irreversible and/or irretrievable commitment of resources; and impacts on long-term productivity.

## 1.8 ORGANIZATION OF THE PEIS

This PEIS is divided into two volumes. Volume I contains the Executive Summary and the main text, and Volume II contains technical appendixes that

provide supporting details for the analyses in Volume I and additional project information. This PEIS Executive Summary is also available as a separate publication.

Volume I contains the Executive Summary and ten chapters. Chapter 1 provides an introduction to the Tritium Supply and Recycling Proposal and the approach to this PEIS. Chapter 2 presents the Purpose of and Need for the Department of Energy's Action. Chapter 3 describes the Tritium Supply and Recycling Proposal and Alternatives. Chapter 4 includes discussions of the Affected Environment and Environmental Consequences of the Alternatives, and chapter 5 contains Environmental, Occupational Safety and Health Permits, and Compliance Requirements. The remaining chapters contain references; a list of preparers; a list of agencies, organizations, and persons to whom copies of this PEIS were sent; a glossary; and an index.

Volume II contains nine appendixes of technical information in support of the environmental analyses presented in Volume I. These appendixes contain information on the following issues: nuclear facilities; air quality and acoustics; biotic resources; socioeconomics; human health; facility accidents; intersite transportation; environmental management; and summary comparison of environmental consequences of the tritium supply and recycling alternatives.

## 1.9 Preparation of the PEIS

This PEIS has been prepared in accordance with Section 102(2)(c) of NEPA as amended (42 U.S.C. 4321 *et seq.*), and implemented by regulations promulgated by the CEQ (40 CFR 1500-1508) and as provided in the DOE NEPA regulations (10 CFR 1021). The organization of this document (as described in section 1.9) is consistent with CEQ regulations (40 CFR 1502.10).

# CHAPTER 2

# Chapter 2

# CHAPTER 2: PURPOSE OF AND NEED FOR THE DEPARTMENT OF ENERGY'S ACTION

***Chapter 2 discusses the Department of Energy's purpose of and need to provide a tritium supply and recycling capability.***

## 2.1 PURPOSE OF AND NEED FOR THE DEPARTMENT OF ENERGY'S ACTION

Since nuclear weapons came into existence in 1945, a nuclear deterrent has been a cornerstone of the Nation's defense policy and national security. The President reiterated this principle in his July 3, 1993, radio address to the Nation. Tritium is used to enhance the yield of nuclear weapons and allows for the production of smaller or more powerful weapons. The United States has based its strategic nuclear systems on designs that use tritium and thus the Nation requires a reliable supply source of tritium to maintain the nuclear weapon stockpile. Tritium has a relatively short radioactive half-life of 12.3 years. Because of this relatively rapid radioactive decay, tritium must be replenished periodically in nuclear weapons to ensure that they will function as designed. Over the past 40 years, the Department of Energy (DOE) has built and operated 14 reactors to produce nuclear materials, including tritium. Today, none of these reactors is operational, and no tritium has been produced since 1988.

Pursuant to the *Atomic Energy Act* of 1954, DOE is responsible for developing and maintaining the capability to produce nuclear materials that are required for the defense of the United States, such as tritium. The primary use of tritium is for maintaining the Nation's stockpile of nuclear weapons as directed by the President in the Nuclear Weapon Stockpile Plan (section 1.4.1).

The Nuclear Weapons Stockpile Plan is forwarded annually from the Secretaries of the Departments of Energy and Defense via the National Security Council to the President for approval. The Nuclear Weapons Stockpile Plan reflects the size and composition of the stockpile needed to defend the United States. The Plan provides an assessment of DOE's ability to support the proposed stockpile. Many factors are considered in the development of the Nuclear Weapons Stockpile Plan, including the status of the currently approved stockpile, arms control negotiations and treaties, Congressional constraints, and the status of the nuclear material production and fabrication facilities. Revisions of the Nuclear Weapons Stockpile Plan could be issued when any of the factors indicate the need to change requirements established in the annual document. The current Nuclear Weapons Stockpile Plan, which was approved by President Clinton on March 7, 1994, authorizes weapons production and retirement through fiscal year 1999. The analysis in this Programmatic Environmental Impact Statement (PEIS) is based on the requirements of the Nuclear Weapons Stockpile Plan. Appendix CA, which is classified, contains quantitative projections for tritium requirements based on the 1994 Nuclear Weapons Stockpile Plan and details of a transportation analysis conducted by the National Security Council of shipping routes involved in nuclear weapons production.

Even with a reduced nuclear weapons stockpile and no identified requirements for new nuclear weapons production in the foreseeable future, an assured long-term tritium supply and recycling capability will be required to maintain the weapons determined to be needed for national defense under the prevailing Nuclear Weapons Stockpile Plan. Presently, no source of new tritium is available. The effectiveness of the United States nuclear deterrent capability depends not only on the Nation's current stockpile of nuclear weapons or those it can produce, but also on its ability to reliably and safely provide the tritium needed to support these weapons.

Until a new tritium supply source is operational, DOE will continue to support tritium requirements

by recycling tritium from weapons retired from the Nation's nuclear weapons stockpile (section 3.4.1). However, because tritium decays relatively quickly, recycling can meet the tritium demands for a limited time. Current projections, derived from classified projections of future stockpile scenarios, indicate that recycled tritium will adequately support the Nation's nuclear weapons stockpile until approximately 2011 (figure 2.1–1). After that time, without a new tritium supply source, it would be necessary to use the strategic reserve of tritium to maintain the readiness of the nuclear weapons stockpile. The strategic reserve of tritium contains a quantity of tritium maintained for emergencies and contingencies. In such a scenario, once the strategic tritium reserve was depleted, the nuclear deterrent capability would degrade because the weapons in the stockpile would not be capable of functioning as designed. Eventually, the nuclear deterrent would be lost. The proposed tritium supply and recycling facilities would provide the capability to produce tritium safely and reliably to meet the Nation's defense requirements well into the 21st century while also complying with environment, safety, and health (ES&H) standards.

DOE has analyzed the activities that must take place to bring a new tritium supply source into operation. The analysis indicates that it will take approximately 15 years to research, develop, design, construct, and test a new tritium supply source before new tritium production can begin. Thus, to have reasonable confidence that the Nation will be able to maintain an effective nuclear deterrent, prudent management dictates DOE to proceed with the proposed action now. In addition, DOE must meet a statutory deadline of March 1, 1995, to issue a PEIS addressing tritium supply alternatives (Public Law 103-160, section 3145).

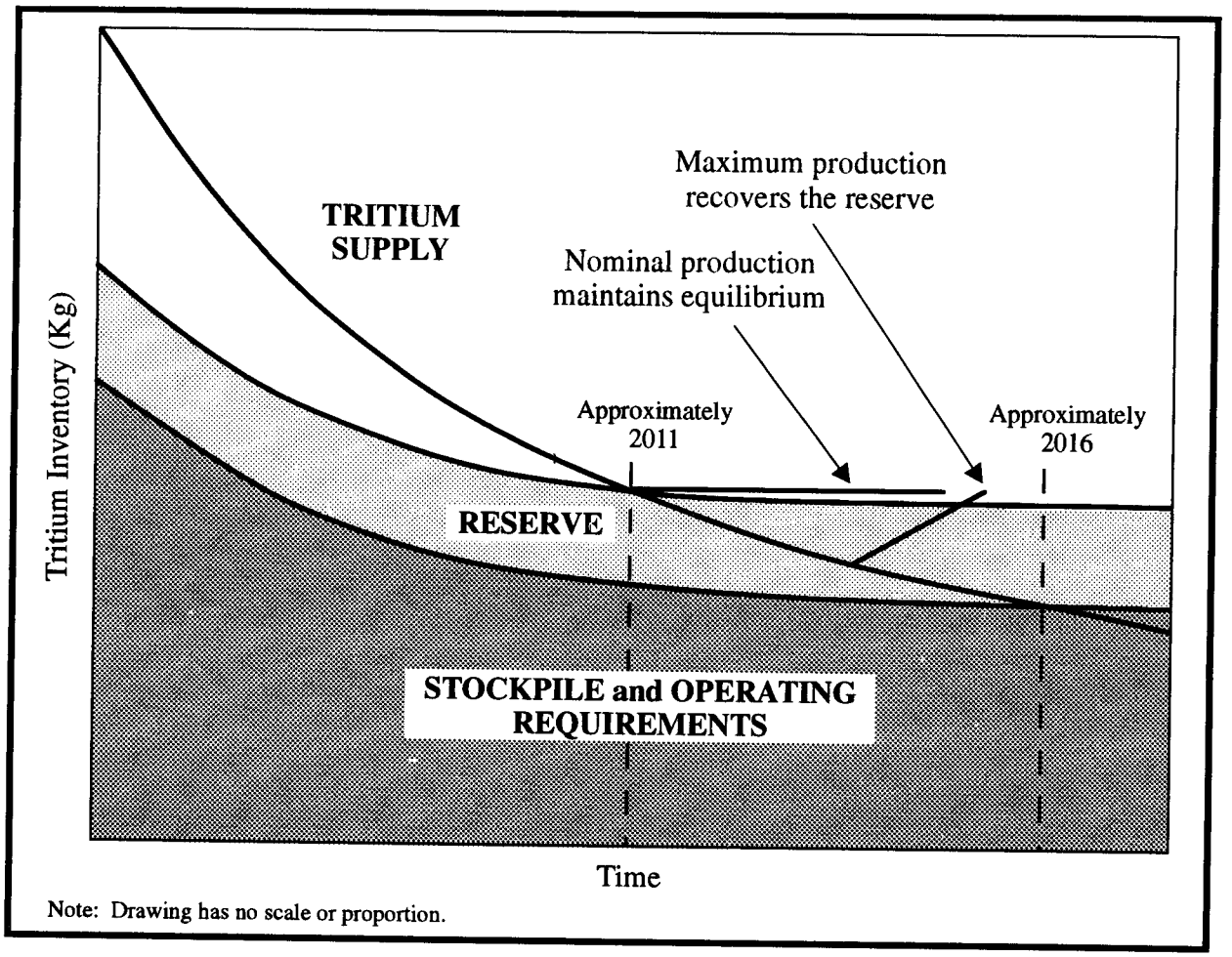


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**FIGURE 2.1–1.**—***Estimated Tritium Inventory and Reserve Requirements.***

# CHAPTER 3

# Chapter 3

# CHAPTER 3: TRITIUM SUPPLY AND RECYCLING ALTERNATIVES

***Chapter 3 provides a detailed description of the tritium supply and recycling alternatives for meeting the Nation's nuclear weapons stockpile tritium supply requirements. The chapter begins with a summary of the development of the alternatives, followed by a description of these alternatives. The chapter concludes with a summary comparison of the environmental impacts of the tritium supply and recycling alternatives.***

## 3.1 DEVELOPMENT OF TRITIUM SUPPLY AND RECYCLING ALTERNATIVES

Tritium is used in nuclear weapons to enhance their performance and to enable the design and production of smaller and more powerful weapons. Since the United States based its design of nuclear weapons on the use of tritium, an assured supply of this isotope is necessary to ensure that the Nation's nuclear weapons stockpile is properly manufactured and maintained. Tritium has a relatively short radioactive half-life of 12.3 years, decaying at the rate of 5.5 percent per year. Because of this radioactive decay, it must be replenished periodically in nuclear weapons so their effectiveness is preserved. Currently, the U.S. has no source of new tritium; the last tritium was produced in 1988. Without new production, the Nation's supply of tritium will decrease, through radioactive decay, to the point where the effectiveness of the nuclear weapons stockpile and the cornerstone of our Nation's defense policy, nuclear deterrence, would be lost.

This *Tritium Supply and Recycling Programmatic Environmental Impact Statement* (PEIS) evaluates the potential direct, indirect, and cumulative environmental impacts associated with alternatives for the siting, construction, and operation of tritium supply and recycling facilities at each of five candidate sites. This PEIS assesses the environmental impacts of a range of reasonable alternatives, including No Action, in sufficient detail to allow for meaningful consideration of their comparative merits.

This PEIS evaluates alternative tritium supply technologies against a baseline tritium requirement (i.e., a specific quantity of tritium, the exact amount of which is classified). Understanding the baseline tritium requirement is crucial to understanding the alternatives and the analysis in this PEIS. The baseline tritium requirement is the amount necessary to support the Nuclear Weapons Stockpile Plan, which is approved by the President as discussed in section 1.1 of this PEIS. In this PEIS, the baseline tritium requirement is approximately 3/8ths the tritium requirement that was analyzed in the New Production Reactor Draft EIS published in April, 1991. This is the tritium requirement "baseline" which the tritium supply technologies must support, and against which they are assessed.

This baseline tritium requirement is made up of two specific components: (1) a steady-state tritium requirement to make up for tritium lost through natural decay; and (2) a surge tritium requirement to replace any tritium which might be used in the event the Nation ever dipped into, or lost, its tritium reserve. The sizing of the surge capacity is based on the requirement set forth in the stockpile plan to reconstitute the entire reserve in a five year period. The steady-state component accounts for approximately 50 percent of the baseline tritium requirement, while the surge accounts for the remaining 50 percent. Tritium supply technologies evaluated in this PEIS must be able both to support the steady-state tritium requirement (a specific quantity of tritium every year), and make up for any lost tritium reserves.

Depending on the specific tritium supply technology, there may be two different ways to meet these requirements: (1) construct a tritium supply facility large enough to satisfy the entire baseline tritium requirement, operate that facility at a reduced level to

meet the steady-state requirement, and increase the operating tempo up to baseline level if necessary; or (2) if sufficient flexibility exists, construct and operate a tritium supply facility that would satisfy the steady-state tritium requirement (approximately 50 percent of the baseline tritium requirement), and be capable of adding capacity (adding modifications to the steady-state sized facility) in a timely enough fashion to meet the surge tritium requirements.

This PEIS assesses alternatives for both cases. Tritium supply technologies representative of the first case are the Heavy Water Reactor (HWR), the Modular High Temperature Gas-Cooled Reactor (MHTGR), and the Advanced Light Water Reactor (ALWR) (Large and Small). Because the addition of capability for these reactors would take more than 5 years, they must be constructed to meet the entire baseline tritium requirement. The only tritium supply technology representative of the second case is the Accelerator Production of Tritium (APT). The APT is the only technology which has the flexibility to be initially constructed to meet the steady-state tritium requirement and enhanced as necessary to meet the baseline tritium requirement.

### 3.1.1 Planning Assumptions and Basis for Analysis

A number of planning assumptions and considerations form the basis of the analyses and impact assessments presented in this PEIS. These considerations and assumptions follow:

- The purpose of the Department's action is to produce the tritium needed to maintain the Nation's nuclear weapons stockpile.

- Preconceptual designs are utilized to represent tritium supply technologies and recycling facilities being considered for construction at candidate sites. These facilities are briefly described in section 3.4 and are described in greater detail in appendix A. Design maturity of the tritium facilities varies greatly. For example, designs for some of the tritium supply technologies are more mature than others (e.g., HWR technology, a past effort from the New Production Reactor Program, is more mature than that of the APT). However, due to large reductions in estimated future requirements for tritium (resulting in a new requirement equal to approximately 40 percent of the baseline estimate represented in *Environmental and other Evaluations of Alternatives for Siting, Constructing, and Operating New Production Reactor Capacity* (DOE/NP-0014)), even those designs have been downsized to meet reduced requirements. The technical feasibility of each of these alternate technologies is presented in the *Tritium Supply and Recycling Plants Technical Reference Report*. Construction and operational resource requirements are representative numbers only and may change slightly as more data become available.

- Sizing of the tritium supply technologies and recycling facilities is based upon the periodic requirement to replace tritium inventories lost to radioactive decay. Stockpile sizing projections have been developed jointly by the Department of Defense (DOD) and the Department of Energy (DOE). This process, which culminates in a Presidential directive, is described in section 1.1. These projections and related analyses take into account initiatives and agreements that have substantially reduced the required number of nuclear weapons. New facilities will be designed with the capacity to support tritium requirements for the projected stockpile and to make up the loss of tritium reserves within a 5-year period. An APT, with a reduced capacity, could initially be built to maintain tritium supply at a level which would support the projected stockpile, but which would have the capability, if necessary, to be modified to meet surge production requirements to reconstitute the tritium reserve. The steady-state component of this option accounts for approximately 50 percent of the total tritium requirement, while the surge accounts for the remaining 50 percent.

- Under the No Action alternative, neither new tritium supply and recycling facilities nor modification/upgrading of the existing recycling facilities at the Savannah River Site (SRS) would be done. This alternative represents a reference condition for each site against which the tritium supply technologies and recycling facilities can be compared. Under No Action, future stockpile tritium requirements would be supported as long as possible by recycling tritium from retired weapons. Eventually, tritium requirements could not be met.

- This PEIS does not attempt to identify specific locations on each site for any of the proposed tritium facilities; however, reference locations used to evaluate the potential environmental impacts of the tritium supply technologies and recycling facilities have been selected at each candidate site. These locations were designated by the individual sites and are consistent with their internal site development plans. These reference locations are designated as the tritium supply site (TSS) and would not interfere with Superfund sites. In general, undeveloped areas are used so that any potential environmental impacts would be greater than those projected for a developed location. These reference locations are defined for each site in sections 4.2 through 4.6. The characterization of the affected environment addresses the entire candidate site and the affected region surrounding each site. The region varies by resource, but generally extends to a 50-mile radius from the center of each site.

- The best available data have been used to represent existing conditions at candidate sites. In some cases, information that is several years old represents the best available data regarding design or upper-bound operating conditions of facilities that are now functioning at reduced capacities due to lower workload. Since annual environmental reports take up to a year and sometimes longer to be approved and published, the latest publicly available environmental monitoring and annual report data are used. All candidate sites have reviewed and updated as appropriate the affected environment sections to accurately describe the site and its environment.

- Both construction and operation impacts are considered for all resources at all sites. Construction impacts are generally short-term, while operation impacts are expected to be long-term. The period of construction for each alternative varies; however, for analytical purposes, full operations are assumed to begin during the year 2010 and continue until the middle of the 21st century. The Phased APT for reduced tritium requirements would enable operations to begin during the year 2008. For purposes of analysis, the representative years have been selected to portray key phases of the project and are as follows: 2005—representative year for peak construction activities, and 2010, 2030, and 2050—representative years for the beginning, middle, and end of the operations phase, respectively.

- Generated waste will be managed in accordance with applicable Federal, state, and local laws, regulations, and requirements, as well as DOE's internal waste management requirements, including DOE's pollution prevention and waste minimization policy. A separate PEIS being prepared by the DOE Office of the Assistant Secretary for Environmental Management (EM) will address waste management options for all DOE-generated wastes. The *Environmental Management Programmatic Environmental Impact Statement* (DOE/EIS-0200) will address the treatment, storage, and disposal of radioactive, hazardous, and mixed wastes to include treatment technology application or development. Accordingly, an important consideration in planning for the tritium facilities would be to ensure that wastes can be safely

packaged, stored, and transported in compliance with applicable regulatory requirements until viable treatment and disposal options are available.

- Baseline process technologies have been selected for tritium supply technologies and recycling facilities and are integral to the preconceptual designs. The design goals of all new facilities include consideration of waste minimization and pollution prevention to minimize facility and equipment contamination thereby making the future decontamination and decommissioning (D&D) of these facilities as simple and inexpensive as feasible. The current level of technical detail is not developed enough so that the environmental impacts associated with D&D of any new facilities could be quantified and evaluated in this PEIS. These impacts would be the subject of future tiered NEPA reviews when those facilities are proposed for retirement.

- The impacts associated with the storage of spent nuclear fuel generated from a new tritium supply facility are analyzed in this PEIS. Impacts presented are based on the management of this spent nuclear fuel at the generation site, either in pools or dry storage bins as appropriate for the type of fuel. Eventually, the spent nuclear fuel would be packaged and transported to a site for ultimate disposition, such as a suitable repository. DOE presently is evaluating the Yucca Mountain Site in Nevada as a repository site, but no acceptance criteria has been established to date. Thus, this PEIS does not assess any long-term impacts associated with ultimate disposition of spent nuclear fuel in a repository because at the present time such impacts are too speculative.

- Low-level waste (LLW) will be disposed of onsite unless specifically prohibited or restricted. Mixed LLW would be stored in *Resource Conservation and Recovery Act* (RCRA)-permitted facilities until treatment to land disposal restriction requirements is available. Sanitary (e.g., sewage and industrial) wastewater would be treated onsite. Hazardous waste generated at the tritium supply and recycling facilities would be accumulated, packaged, shipped, and in some instances stored in accordance with all applicable regulatory requirements.

- This PEIS broadly analyzes the environmental impacts associated with construction and operation of electrical generation capacity for those reactors (MHTGR and ALWR) capable of generating electricity. However, DOE has not proposed to sell or use the by-product steam or electricity that could be generated. Although the sale of steam for power or the generation of electricity is possible, the conditions of such a sale are highly uncertain. Moreover, it is highly uncertain whether such activities would be proposed in the future because of the view held by some that such activities would blur the distinction between military and civilian technology. Accordingly, the impacts of such events are too speculative to be evaluated in detail at this time. For a general discussion of such impacts, see section 4.8.1. Appropriate NEPA reviews would be conducted in connection with any future proposals for such sale.

- For electricity needs, particularly those of the APT, this PEIS assesses the availability of power from the regional power pools that service the various sites. Any additional capacity that would be required is identified. While electricity needs are foreseeable, the specific manner in which that need would be provided is uncertain, particularly with regard to the type of electrical facility, and its location within a regional power pool. It is likely that the electrical requirement would be met by facilities well away from the site itself, or as an option a dedicated power plant (for the APT) could potentially be constructed at a site. Thus, this PEIS assesses only the impacts on the regional power pools of

providing the required electricity for each tritium supply technology at each site. A generic discussion of the environmental effects from a dedicated power plant for the APT is provided in section 4.8.2.

- Enriched uranium to fuel the fission reactor technologies would be available from existing sources. Therefore no new facilities are necessary to provide enriched uranium fuel.

- This PEIS presupposes that the United States Government would design, construct, and operate a new tritium supply facility at any of the five candidate sites. It is conceivable that private sources could design, construct, and operate a tritium supply facility at any of the same five sites and lease irradiation services to the government. In this case the environmental impacts would be the same as the corresponding alternatives evaluated in the PEIS.

### 3.1.2 Environmental Impact Analysis

This PEIS evaluates the direct, indirect, and cumulative impacts associated with the tritium supply and recycling alternatives. For the reactors, this includes construction impacts of a full-sized facility, and operational impacts associated with producing the baseline tritium requirement (which is the greatest amount of tritium, and thus, the greatest operating tempo that might be required in any given year). This PEIS acknowledges that the reactors would likely be operated at less than the baseline tritium requirement (i.e., in most years, it would only be necessary to operate the facilities at 50 percent of the baseline tritium requirement in order to support the steady-state tritium requirement). This PEIS also provides a discussion of differences, if any, in environmental impacts between the conservative baseline tritium requirement operating tempo and the steady-state tritium requirement operating tempo. However, since it is reasonably foreseeable that the reactors would be required to operate to support the baseline tritium requirement, this is the case analyzed in the greatest detail in this PEIS. This case thus bounds the potential impacts associated with producing the steady-state tritium requirement.

For the APT, which has the flexibility to be initially constructed to meet the steady-state tritium requirement and enhanced as necessary to meet the baseline tritium requirement, this PEIS assesses the construction impacts of a full-sized baseline facility because it is highly uncertain when additional capacity might be required. Thus, in order to bound the potential construction impacts, this PEIS assumes that all construction is performed during the same construction period even though it is likely the construction would be phased in. Operationally, using the same logic as that of the reactors, the impacts associated with producing the baseline tritium requirement are presented. The APT would likely be operated at less than the baseline tritium requirement (i.e., again, in most years, it would only be necessary to operate the facilities at 50 percent of the baseline tritium requirement in order to support the steady-state tritium requirement). This PEIS also provides a discussion of differences in environmental impacts between the conservative baseline tritium requirement operating tempo and the steady-state tritium requirement operating tempo.

### 3.1.3 Alternatives Considered but Eliminated from Detailed Study

By law, DOE is required to support the Nuclear Weapons Stockpile Plan. In order to do this, DOE must maintain a nuclear weapons production, maintenance, and surveillance capacity consistent with the President's Stockpile Plan. For the proposed action, the following alternatives were considered but eliminated from detailed study for the reasons stated:

**Purchase Tritium From Foreign Sources.** DOE has considered the purchase of tritium from other sources, including foreign nations. Conceptually, the purchase of tritium from foreign governments could provide a fraction of the tritium requirement. However, while there is no national policy against purchase of defense materials from foreign sources, DOE has determined that the uncertainties associated with obtaining tritium from foreign sources render this alternative unreasonable for an assured long-term supply.

**Redesign of Weapons to Require Less or No Tritium.** The nuclear warheads in the enduring stockpile were designed and built in an era when the tritium supply was assured, when underground

nuclear testing was being conducted, and when military needs required that the warheads be optimized in terms of weight and volume. Replacing these warheads with new ones that would use little or no tritium for the sole reason of reducing overall tritium demand would be infeasible and unreasonable. Without underground nuclear testing to verify their safety and reliability, new warhead designs cannot deviate very far from current designs which require the use of tritium. Even with underground testing to facilitate new designs and a fully operational production complex, it would still take many years to build enough warheads to replace the enduring stockpile. Therefore, replacing the enduring stockpile of warheads with new designs would most likely take longer and could cost more than constructing and operating a new tritium supply facility. Because neither the President nor the Congress has proposed that the Government embark on a costly and expansive design, testing, and construction program solely to eliminate tritium requirements, weapons redesign to use less or no tritium is not a reasonable short- or long-term alternative.

**Use of Existing Department of Energy Reactors or Accelerators.** DOE (and its predecessor agencies) has designed, constructed, and operated a number of nuclear reactors over the past 50 years. The majority of these reactors were designed to assist in the development of nuclear research and safety standards development. DOE has also constructed nuclear reactors to produce the materials required to support the production and maintenance of nuclear weapons and has constructed nuclear reactors in support of the Naval Propulsion Program.

Among the first experimental reactors were the water boiler at Los Alamos National Laboratory and CP-3 at Argonne National Laboratory-West, which were completed in 1944. Since then, numerous experimental and research reactors were constructed for a variety of purposes, including material tests, new reactor concepts, and safety experiments. Only four DOE research reactors are currently in operation: The High Flux Isotope Reactor at Oak Ridge Reservation (ORR); the High Flux Beam Reactor at Brookhaven National Laboratory; and the Experimental Breeder Reactor-II and the Advanced Test Reactor at the Idaho National Engineering Laboratory (INEL). In addition, there are some low power/critical facilities supporting medical research (at Brookhaven) and supporting reactor core configuration research (at Argonne National Laboratory-West at INEL). None of these facilities are large enough to produce the amount of tritium required to support the projected stockpile requirements. All are currently committed to existing programs, and were constructed in the early 1960s, rendering their design life reliability unsuitable for the timeframe required for a new, assured, long-term tritium supply facility.

Of the existing DOE reactors that are currently not being operated, only one has the potential for producing any significant quantities of tritium: the Fast Flux Test Facility at the Hanford Site. This facility was designed and constructed to perform materials research for the national liquid-metal breeder reactor program. This small (440-megawatt thermal (MWt)) experimental reactor, based on liquid-metal reactor technology, could, after substantial core and cooling system modifications, as well as target technology development, have the potential to supply a significant percentage of the steady state tritium requirement. The Fast Flux Test Facility, however, was designed in the late 1970s and began operation in 1980. In 2010, it will already be 10 years past its design 20-year lifetime. Relying on the ability to modify and operate Fast Flux Test Facility well into the middle of the next century is not a reasonable alternative.

DOE also constructed and operated more than a dozen nuclear reactors for production of nuclear materials at SRS and the Hanford Site, starting with the early part of the Manhattan Project during World War II. None of these reactors is currently operational. Of those reactors specifically designed to produce nuclear materials for the nuclear weapons program, the K-Reactor at SRS is the only remaining reactor which could be capable of returning to operation. It is presently in a "cold stand-by state" and has not been operated since 1988. The reactor was shut down for major environmental, safety, and health upgrades, to comply with today's stringent standards. DOE discontinued the K-Reactor Restart Program when the reduced need for tritium to support a smaller stockpile delayed the need for tritium. In this context, reliance upon the ability to upgrade and operate well into the middle of the next century a first generation reactor designed in the 1940s is not a reasonable alternative for new, long-term, assured tritium supply.

DOE has been a world leader in the design and construction of particle accelerators, and currently operates six national facilities. Of the existing research accelerators, none is capable of producing significant quantities of tritium. The existing DOE research accelerators are all of the pulsed design and are only capable of producing low power accelerator beams in the 800 kilowatt (kW) range. A production accelerator facility, utilizing continuous wave operation, would be required to deliver a high power proton beam of 100 megawatt (MW) for tritium production. None of the existing research accelerators could be reasonably upgraded to meet the long-term, assured tritium requirements.

**Use of Commercial Reactors.** Tritium could be produced directly in existing light water reactors by irradiating target rods made from lithium. However, the production of tritium for defense purposes in nuclear reactors which generate electricity for commercial sale would be contrary to the long-standing policy of the United States that civilian nuclear facilities should not be utilized for military purposes. Such use of commercial reactors would make the United States nonproliferation efforts much more difficult because other countries could demand equal footing. For this reason, DOE does not consider the use of commercial reactors to be a reasonable alternative for a long-term assured supply of tritium to be evaluated in the PEIS. However, as previously discussed, the PEIS will contain an evaluation of the impacts associated with the use of an existing light water reactor to produce tritium, whether an existing reactor were used on a contingency basis to produce tritium in a national emergency, or the Department chose at some future date to purchase an existing reactor and convert it to defense purposes as a long-term source of tritium. Therefore, a discussion of the generic environmental impacts of the production of tritium in a commercial reactor is presented in section 4.10.

**Alternative Sites.** Section 3.3.1 describes the process that was carried out to identify the range of reasonable site alternatives for the tritium supply and recycling facilities that are considered in this PEIS. The process of determining these reasonable tritium supply alternative sites has been evolutionary, starting with the engineering studies and criteria developed by the New Production Reactor program, then utilizing additional criteria and considerations from the Reconfiguration Program, information related to changing missions at DOE sites, and input from public scoping.

During the preparation of this Draft PEIS, the Department has continued to assess other alternative sites. In fact, once the APT was added as a potential tritium supply technology, an assessment was conducted to determine if the Los Alamos National Laboratory, which operates a linear accelerator and is the home of significant accelerator expertise, would be a reasonable site for a tritium producing accelerator.

The APT conceptual designs for tritium supply have established that evaporative cooling towers would be used to dissipate the heat generated in the tritium target assemblies and in the accelerator facility. These APT cooling water requirements are significantly greater than the current regulated allotment of water for Los Alamos National Laboratory and increasing the allotment to support the APT water requirement would be impractical and infeasible, and in any event beyond DOE's control.

It may be possible that an APT could use non-evaporative cooling towers which would greatly reduce the water requirements. However, there is sufficient technical uncertainty regarding the feasibility and practicality of using non-evaporative cooling towers for a continuous wave APT to render this option unacceptable as a source for the Nation's only supply of tritium. The other five sites being analyzed in this PEIS could reasonably support the water requirements of the APT using evaporative cooling towers and, thus, would not incur the technical uncertainty and risk of Los Alamos National Laboratory. Thus, DOE has concluded that Los Alamos National Laboratory is not a reasonable site for an accelerator to produce tritium (LA DOE 1994a:1).

## 3.2 Tritium Supply and Recycling Alternatives

This Tritium Supply and Recycling PEIS evaluates the environmental impacts associated with alternatives for only one functional area of the nuclear element of the Complex: tritium supply and tritium recycling. The nonnuclear element of the Complex

has already been evaluated in the *Nonnuclear Consolidation Environmental Assessment (EA) Nuclear Weapons Complex Reconfiguration Program* (DOE/EA-0792). The specific alternatives evaluated in this Tritium Supply and Recycling PEIS are presented in figure 3.2–1 and explained in section 3.2.2. The remaining elements of the Complex, other than tritium supply and recycling, will be covered in the new Stockpile Stewardship and Management PEIS described in section 1.5.1.

### 3.2.1 No Action

To satisfy the requirements of the NEPA, No Action is presented for comparison with the action alternatives. Under No Action, DOE would not establish a new tritium supply capability, the current inventory of tritium would decay, and DOE would not meet stockpile requirements of tritium. This would be contrary to DOE's mission as specified by the *Atomic Energy Act* of 1954, as amended. Sites would continue waste management programs to meet the legal requirements and commitments in formal agreements and would proceed with cleanup activities. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for the year 2010 and beyond. The current DOE missions assumed to continue under No Action are listed in section 3.3 for each candidate site.

### 3.2.2 Tritium Supply and Recycling

The four technologies considered as a new supply of tritium include: HWR, MHTGR, ALWR, and APT. Both Large (1,300 MWe) and Small (600 MWe) options for the ALWR and a phased option for the APT are evaluated. The PEIS also includes an analysis of the MHTGR and ALWR technologies for tritium production together with plutonium disposition and steam/electricity production. Descriptions of these technologies and their options are provided in section 3.4. The five candidate sites evaluated for such a facility are INEL, the Nevada Test Site (NTS), ORR, the Pantex Plant, and SRS. Descriptions of specific sites are given in section 3.3.

This PEIS provides environmental analyses to support a decision to select both the tritium supply technology and the location of the tritium supply and recycling facilities. If the tritium supply facility was located at any site other than SRS, the tritium recycling function could be provided either by collocating a new tritium recycling facility at that site or by the upgraded tritium recycling facilities at SRS. If the new tritium supply facility was located at SRS, it would utilize upgraded recycling facilities at SRS. As shown in figure 3.2–1, the following alternatives for tritium supply and recycling will be analyzed.

- HWR and New Recycling Facility—Collocation of an HWR for tritium supply and a new tritium recycling facility at either INEL, NTS, ORR, or Pantex. Tritium recycling facilities at SRS would be phased out if any of these alternatives were chosen.

- HWR and Recycling Facilities Upgrade—Location of an HWR for tritium supply at any of the five candidate sites. The Replacement Tritium Facility and other support facilities at SRS would be upgraded for tritium recycling.

- MHTGR and New Recycling Facility—Collocation of an MHTGR for tritium supply and a new tritium recycling facility at either INEL, NTS, ORR, or Pantex. Tritium recycling facilities at SRS would be phased out if any of these alternatives were chosen.

- MHTGR and Recycling Facilities Upgrade—Location of an MHTGR for tritium supply at any of the five candidate sites. The Replacement Tritium Facility and other support facilities at SRS would be upgraded for tritium recycling.

- ALWR and New Recycling Facility—Collocation of an ALWR for tritium supply and new tritium recycling facilities at either INEL, NTS, ORR, or Pantex. Both large and small reactor options are evaluated at each site. Tritium recycling facilities at SRS would be phased out if any of these alternatives were chosen.

- ALWR and Recycling Facilities Upgrade—Location of an ALWR for tritium supply at any of the five candidate

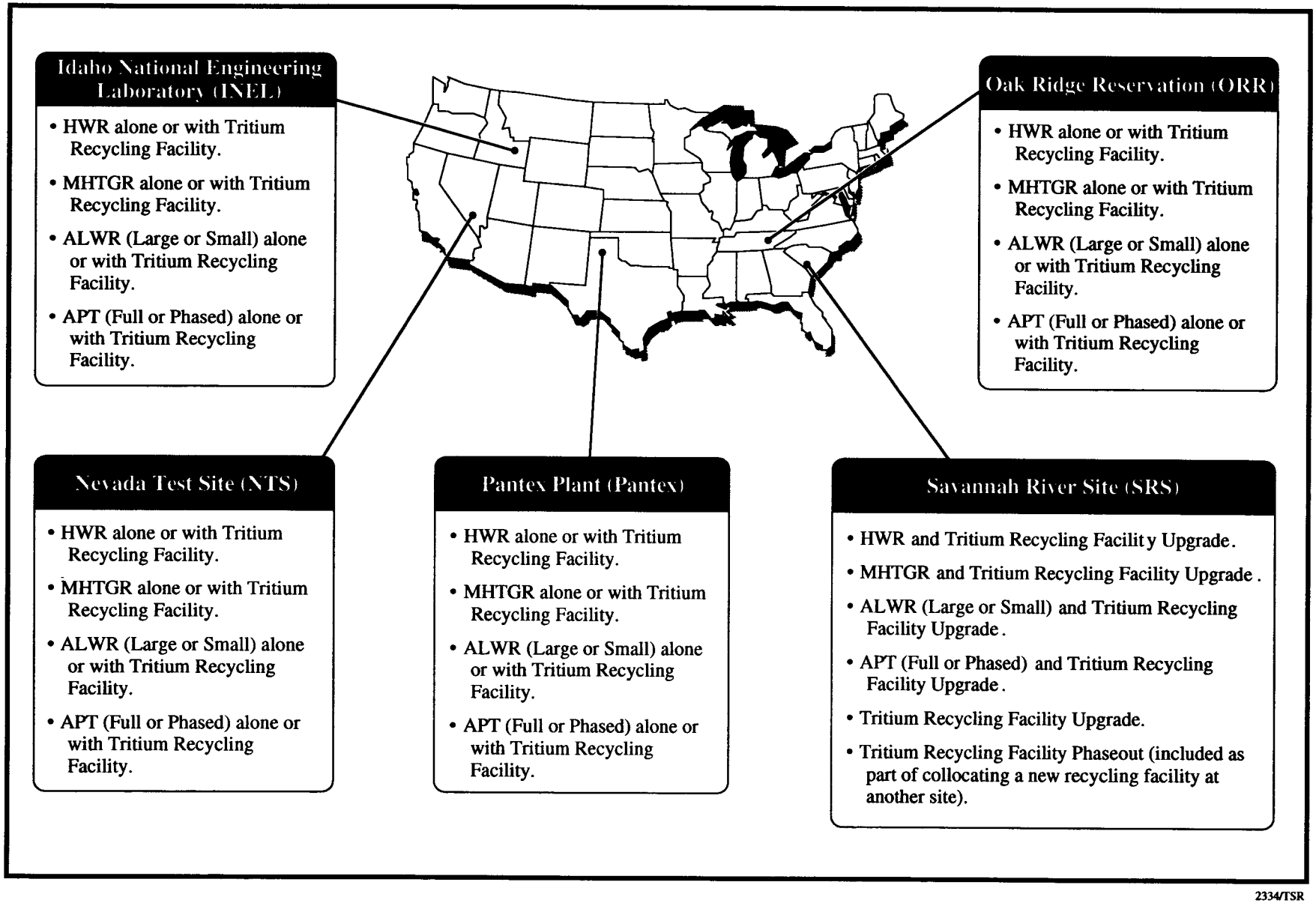


**FIGURE 3.2–1.**—***Tritium Supply and Recycling Alternatives.***

sites. Both large and small reactor options are evaluated at each site. The Replacement Tritium Facility and other support facilities at SRS would be upgraded for tritium recycling.

- APT and New Recycling Facility—Collocation of an APT for tritium supply and a new tritium recycling facility at either INEL, NTS, ORR, or Pantex. The Phased APT option, described in section 3.4.2.4 and appendix section A.2.1.4, will be evaluated for less than baseline operations. Tritium recycling facilities at SRS would be phased out if any of these alternatives were chosen.

- APT and Recycling Facilities Upgrade—Location of an APT for tritium supply at any of the five candidate sites. The Phased APT option will be evaluated for less than baseline operations. The Replacement Tritium Facility and other support facilities at SRS would be upgraded for tritium recycling. Candidate Sites

Under the Phased APT scenario, initial construction of the APT would result in a facility that could only produce the steady-state requirement. Expansion of this facility could be possible at a later date in order to increase tritium production to the baseline requirements if necessary. All five candidate sites will be evaluated for such a facility.

### 3.2.3 Other Missions Beyond Tritium Production

Tritium production is the only mission addressed in this Tritium Supply and Recycling PEIS, although it is possible that some of the tritium supply technology alternatives would be capable of performing missions other than tritium production. Two such examples are plutonium disposition and steam/electricity production.

As discussed in section 1.5.3, alternatives for plutonium disposition are being assessed in the *Storage and Disposition of Weapons-Usable Fissile Materials PEIS*. Nonetheless, this Tritium Supply and Recycling PEIS includes an analysis of the option of utilizing the MHTGR and ALWR technologies for tritium production together with plutonium disposition and steam/electricity production.

### 3.2.4 Commercial Light Water Reactor Contingency

While the purpose of this Tritium Supply and Recycling PEIS is to focus on assessing the reasonable alternatives for a government-owned, long-term assured supply of tritium, programmatic NEPA coverage of tritium production using commercial light water reactors as a contingency is also evaluated. Coverage of this option, which would only be needed in the event of a national emergency, or if the Department chose to purchase an existing reactor and convert it to defense purposes, ensures that the public is informed of DOE's normal and contingency planning for meeting tritium requirements. This analysis is generic and does not identify any specific commercial reactors that might be used if such options were ever required to be implemented.

## 3.3 Candidate Sites

Five locations (INEL, NTS, ORR, Pantex, and SRS) are being considered as candidate sites for the tritium supply facility and tritium recycling facility. All of these sites, with the exception of INEL, are currently performing defense program activities.

### 3.3.1 Site Selection

As shown in figure 3.3.1–1, in mid-1988, at the onset of the New Production Reactor Program, 13 DOE-owned sites were considered as potential locations for deployment of a new production reactor. All sites were evaluated against basic screening criteria and only three, Hanford, INEL and SRS, satisfied the criteria. These three sites were further evaluated by a DOE Site Evaluation Panel against more stringent criteria and were found to be suitable for a new production reactor. A detailed discussion of this selection process is described in the *Implementation Plan for the New Production Reactor Capacity Environmental Impact Statement* (DOE/NP-0003).

Concurrent with the publication in the *Federal Register* on February 11, 1991 (56 FR 5590) of the Notice of Intent (NOI) to prepare a PEIS for Reconfiguration of the Nuclear Weapons Complex, a

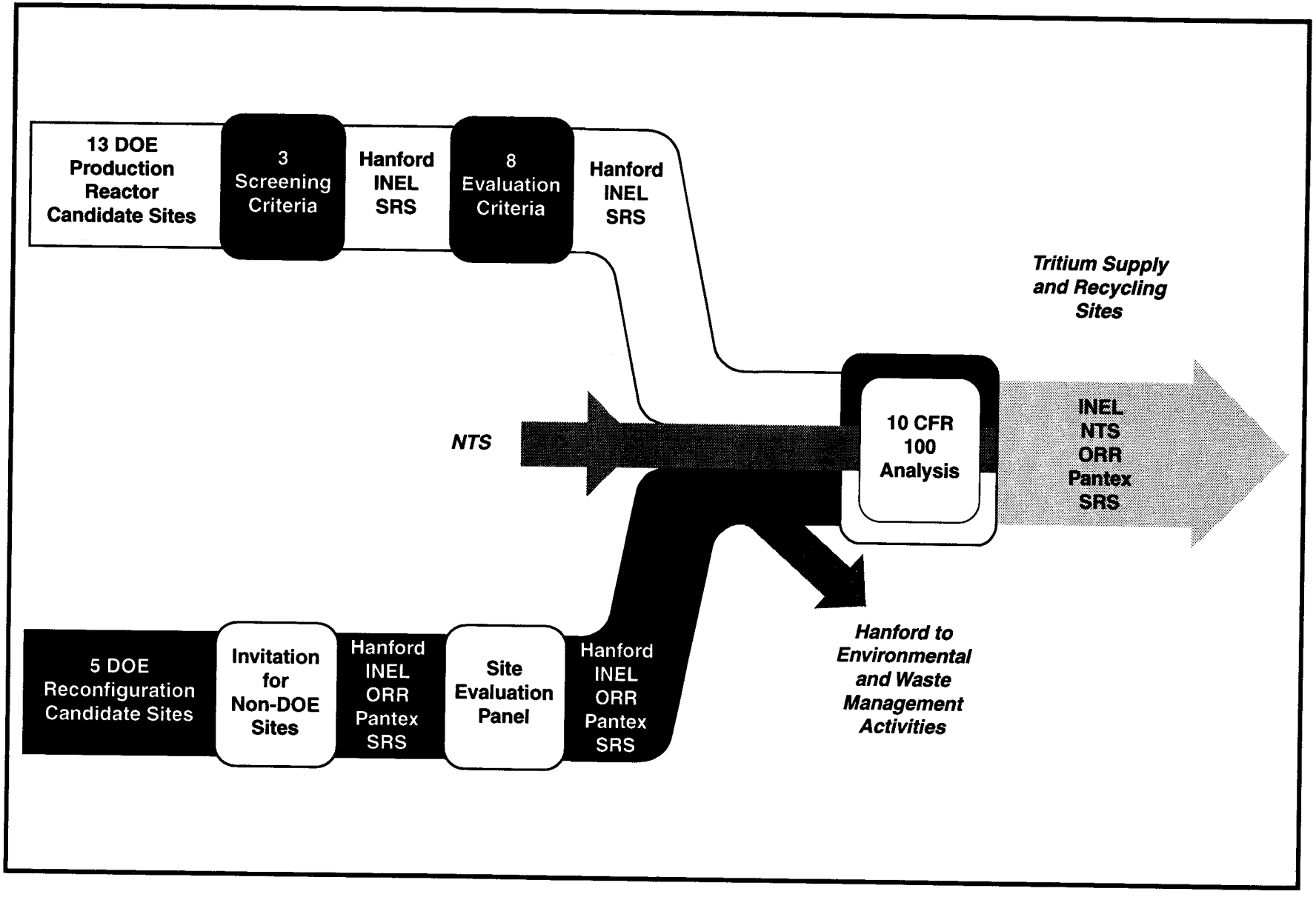


FIGURE 3.3.1–1.—*Site Selection Process.*

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Notice of Availability of an Invitation for Site Proposals for the Nuclear Weapons Complex Reconfiguration Site was also published (56 FR 5595). The invitation solicited proposals for consideration of non-DOE sites and listed five DOE sites which met the initial screening criteria. No additional locations were identified as a result of this invitation.Subsequent evaluation by the Site Evaluation Panel of the DOE sites found them to be fully qualified. These five initial sites were the Hanford Site, INEL, ORR, Pantex, and SRS.

On November 1, 1991, the then Secretary of Energy announced his decision to incorporate the New Production Reactor environmental analysis into the Reconfiguration PEIS. On November 29, 1991, DOE published a notice of opportunity for public comment on this issue (56 FR 60985). The New Production Reactor Program had been evaluating the siting of either a HWR, Light Water Reactor (LWR), or MHTGR technology at either Hanford, INEL, or SRS to provide new tritium supply capability for the Complex. In light of the reduced requirements resulting from the President's initiative to downsize the nuclear weapons stockpile, the tritium production requirement was reduced. This reduction permitted the addition to the Reconfiguration PEIS of the option of producing tritium using a linear accelerator and of downsizing the three reactor technologies to the new goal quantities. The two reconfiguration sites, ORR and Pantex, previously rejected as candidate sites for a New Production Reactor, were then evaluated using 10 CFR 100 reactor siting criteria and found to be acceptable for the downsized reactors.

A Revised NOI to prepare a PEIS was published in the *Federal Register* on July 23, 1993 (58 FR 39528). In this notice, DOE eliminated Hanford from further consideration as a candidate site because all nuclear weapons production functions at that location had been terminated and it was dedicated to environmental and waste management activities. NTS was evaluated using the siting criteria described above and was determined to be a reasonable site alternative for new tritium supply and recycling facilities. The resulting five sites, INEL, NTS, ORR, Pantex, and SRS, are described in the following sections.

### 3.3.2 Idaho National Engineering Laboratory

INEL, located on approximately 570,000 acres near Idaho Falls, ID, was established in 1949 to build, test, and operate various types of nuclear facilities. This site is one of DOE's principal centers for conducting nuclear energy research and providing support to the U.S. Navy nuclear fleet. It has the world's largest and most varied collection of reactors, including research, testing, power, and ship propulsion reactors. There have been 52 research and test reactors at INEL that have been used over the years to test fuel and target design, reactor systems, and overall safety. Currently, there are four reactors in use, three of which are in continuous operation.

In addition to its nuclear reactor research, other INEL facilities are operated to support reactor operations. These facilities include high-level waste (HLW) and LLW processing and storage sites; hot cells; analytical laboratories; machine shops; laundry; railroad; and administrative facilities. Other activities include management of one of DOE's largest storage sites for the LLW and transuranic (TRU) waste generated by defense program activities. Until 1992, spent reactor fuels were reprocessed at the Idaho Chemical Processing Plant to recover enriched uranium and other isotopes. Due to a DOE decision to terminate spent fuel reprocessing, the Idaho Chemical Processing Plant was transferred to the EM program for disposition. There are currently no defense program activities at INEL.

DOE activities at INEL have been divided among nine distinct and geographically separate functional mission areas as listed in table 3.3.2–1. The current functions at INEL can be further grouped into the following two major categories, environmental management activities and other DOE activities.

**Environmental Management Activities.** Environmental management performs research and development activities for waste processing at the Power Burst Facility and provides waste management expertise to the Radioactive Waste Management Complex. The Power Burst Facility supports facilities for research and development for waste reduction programs and the Boron Neutron Capture Therapy Program. Waste management efforts at INEL are directed toward safe and environmentally sound treatment, storage, and disposal of radioactive, haz-

**TABLE 3.3.2–1.—*Current Missions at Idaho National Engineering Laboratory***

| Mission | Description | Sponsor |
|---|---|---|
| Idaho Chemical Processing Plant | Transferred to management of EM. | Assistant Secretary for Environmental Management |
| Radioactive Waste Management Complex | Provide waste management functions for present and future site and department needs. | Assistant Secretary for Environmental Management |
| Power Burst Area | Perform waste processing, technology research, and development. Provide interim storage for hazardous wastes. | Assistant Secretary for Environmental Management |
| Test Area North | Perform research on reactor safety operations and conduct a specific manufacturing capability project. | Office of Nuclear Energy |
| Auxiliary Reactor Area | Perform materials testing and environmental monitoring. | Office of Nuclear Energy |
| Argonne National Laboratory-West | Perform breeder reactor irradiation tests. | Office of Nuclear Energy |
| Test Reactor Area | Perform irradiation service, develop nuclear instruments, conduct safety programs, and perform geological research. Develop methods to meet radioactive release limits. | Office of Nuclear Energy; Office of Naval Reactors |
| Naval Reactors Facility | Standby facility for conducting ship propulsion reactor research and training. | Office of Naval Reactors |
| Central Facilities Area | Provide centralized support services for the site. | Idaho Operations Office |

ardous, and sanitary waste generated from facility operations. Details of environmental management activities are discussed in section 4.2.2.10 and appendix H.

A reactor used for thermal fuels behavior studies is now in a standby mode. Major waste reduction facilities include the waste engineering development facility, the waste experimental reduction facility, and the mixed waste storage facility.

**Other Department of Energy Activities.** The following six additional DOE activities are located at INEL:

- The Test Area North complex is the northernmost facility within INEL and consists of several experimental reactors and support facilities conducting research and development activities on reactor performance. These include the technical support facility, the containment test facility, the water reactor research test facility, and the inertial engine test facility. The inertial engine test facility has been abandoned, and no future programs are planned. The remaining facilities support ongoing programs that are expected to continue for the foreseeable future.

- Materials testing and environmental monitoring activities are conducted in the Auxiliary Reactor Area. The facilities in this area are scheduled for D&D.

- Argonne National Laboratory-West supports breeder reactor development and the Waste Isolation Pilot Plant (WIPP) test program, as well as stores plutonium for the DOE Office of Nuclear Energy.

- The Test Reactor Area supports the Advanced Test Reactor. This reactor is used for irradiation testing of reactor fuels and material properties; instrumentation for naval reactors; and production of radioisotopes in support of nuclear medicine, industrial applications, research, and product sterilization. Wastes from this facility are handled by

the Radioactive Waste Management Complex.

- The Naval Reactors Facility is operated for DOE and the U.S. Navy by Westinghouse Electric Corporation under jurisdiction of DOE's Pittsburgh Naval Reactors Office. Included at this facility are the submarine prototypes and the expended core facility. Activities include the testing of advanced design equipment and new systems for current naval nuclear power propulsion plants and obtaining data for future design. Additionally, the facilities are used to provide a comprehensive nuclear plant operational training program for naval personnel. DOD plans to shut down older prototype reactors, leaving operational only the most modern prototype reactors and Expended Core Facility.

- The mission of the Central Facilities Area is to provide effective, site-wide support services including transportation, shop services, health services, radiation monitoring, and administrative offices.

**Non-Department of Energy Activities.** Non-DOE activities at INEL include research being conducted by the National Oceanic and Atmospheric Administration, the U.S. Geological Survey (USGS), and various institutions of higher learning. These activities support the designation of INEL as a National Environmental Research Park.

**Environmental Regulatory Setting.** The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at INEL. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. A brief description of the environmental regulatory setting at INEL follows. More detail is available in appendix section A.1.1.

The State of Idaho has regulatory authority for air, water, solid waste, mixed waste, and hazardous waste management. DOE and the State of Idaho have developed the Environmental Oversight and Monitoring Agreement to assure the citizens of Idaho that their health and safety and the environment are being protected. DOE is required to comply with all applicable environmental laws and regulations and provide technical and financial support for state activities to assess such compliance at INEL.

The INEL air emissions inventory, completed in March 1991, catalogs and characterizes all vents, stacks, and potential sources of air pollutants at INEL. The air toxic compounds inventory for radioactive and other hazardous air pollutants is being compiled, and when added to the air emissions inventory, will serve as the basis for the operating permits required under Title V of the 1990 *Clean Air Act* (CAA).

All nine public water systems within INEL boundaries are currently in compliance with primary drinking water standards. Annual averages for all onsite and offsite drinking water samples were below EPA's maximum contaminant level for community drinking water systems. INEL holds two National Pollutant Discharge Elimination System (NPDES) permit requests for discharges of noncontact cooling water and for discharges of wastewater to the Big Lost River from the Idaho Chemical Processing Plant.

EPA placed INEL on the National Priorities List (NPL) on December 21, 1989. As a result, DOE entered into a Federal Facility Agreement and Consent Order on December 9, 1991, with EPA and the State of Idaho to coordinate cleanup activities under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) and RCRA. The agreement is implemented by an action plan which outlines the remedial action process which will encompass all investigations of hazardous substances and cleanup activities at INEL.

On October 7, 1992, DOE signed another Consent Order with the State of Idaho to resolve the Hazardous Waste Notice of Violation issued by the state after a September 1990 inspection for 23 alleged hazardous waste violations. This Consent Order provides the schedule for corrective actions which,

when completed, will resolve this Notice of Violation.

DOE has proposed to enter into a compliance agreement with the State of Idaho concerning the storage, treatment, and continued generation of land disposal restricted waste that would form the basis for the INEL site-specific mixed waste treatment plan required by the *Federal Facility Compliance Act* of 1992. The proposed agreement would address INEL compliance with the Land Disposal Restrictions of the Hazardous and Solid Waste Amendments of 1984, allowing INEL to continue to operate and to generate, treat, and store mixed wastes.

INEL is not in full compliance at present with the *Toxic Substances Control Act* (TSCA) due to the storage of radioactive polychlorinated biphenyl (PCB)-contaminated equipment and materials. DOE is negotiating a compliance agreement with the State of Idaho for the continued storage of radioactive PCB-contaminated wastes at INEL until a method for their treatment or disposal can be developed.

DOE, the U.S. Navy, and the State of Idaho concurred on the Idaho Agreement on August 9, 1993. The Idaho Agreement encompasses the transportation, receipt, processing, and storage of spent nuclear fuel at INEL. This agreement is a negotiated settlement among the parties to satisfy a June 28, 1993, order by the U.S. District Court for the District of Idaho granting a motion for summary judgment, injunction, and administratively terminating action. The effect of this motion is to limit receipt of spent nuclear fuel at INEL pending completion of an EIS analyzing DOE's spent nuclear fuel activities and certain proposed INEL activities.

### 3.3.3 Nevada Test Site

NTS occupies approximately 864,000 acres in the southeastern part of Nye County in southern Nevada. Located about 65 miles northwest of Las Vegas, NTS is operated by several management and operating contractors under the direction of the Nevada Operations Office. It is a remote, secure facility which maintains the capability for conducting underground testing of nuclear weapons and evaluating the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. The first nuclear test at NTS was conducted in January 1951. Since the signing of the Threshold Test Ban Treaty in 1974, it has been the only U.S. site used for nuclear weapons testing. Approximately one-third of the land (located in the eastern and northwestern portions of the site) has been for nuclear weapons testing, one-third (located in the western portion of the site) has been reserved for future missions, and one-third is used for research and development and other facility requirements. Facilities include nuclear device assembly, diagnostic canister assembly, hazardous liquid spill, and the Radioactive Waste Management Site. In addition, Yucca Mountain, an area on the southwestern boundary of the site, is being evaluated by DOE for siting of a spent nuclear fuel and high-level radioactive waste repository. While the primary purpose of Yucca Mountain is for commercial HLW, it is also slated to receive some military HLW.

Activities at NTS are concentrated in several general areas. Most of the onsite work is related to defense program activities, although there are environmental management, other DOE, and non-DOE activities as well. NTS is a unique facility because it is a large open area into which access is tightly controlled, it has a substantial infrastructure, and it has the capability to handle and run tests with hazardous or radioactive materials. Because of this, activities other than nuclear testing, such as mobile missile transporter tests and nuclear rocket tests, have been carried out for other Federal departments and agencies. The current missions and functions of NTS are shown in table 3.3.3–1.

**Defense Program Activities.** The defense program efforts and the Defense Nuclear Agency (non-DOE activity) activities are closely related, with both contributing to national security. Prior to the moratorium described below, nuclear testing was limited to those tests that supported the safety and reliability of the Nation's nuclear stockpile. The moratorium significantly restricted DOE experiments and virtually eliminated DOE support of Defense Nuclear Agency nuclear tests. In July 1993, the President extended the moratorium on nuclear tests indefinitely (both DOE and DOD). The moratorium started in October 1992, in accordance with the Hatfield Amendment. However, the President also required that NTS retain the capability to resume testing if authorized. The Nevada Operations Office, with DP oversight, has the lead Federal role in maintaining the capability to

**TABLE 3.3.3–1.—*Current Missions at Nevada Test Site***

| Mission | Description | Sponsor |
|---|---|---|
| Maintain Underground Nuclear Testing Program Capabilities | Underground nuclear testing has been suspended; however, the capability to resume testing will be maintained. | Assistant Secretary for Defense Programs |
| Maintain Nuclear Emergency Search Team Program Capabilities | Tests and exercises are carried out to verify procedures and equipment of the Nuclear Emergency Search Team. | Assistant Secretary for Defense Programs |
| Radioactive Waste Management | Manage radioactive and mixed waste facilities. | Assistant Secretary for Environmental Management |
| Support the Yucca Mountain Waste Storage Program | Characterize environment of Yucca Mountain and surrounding area, especially geology, with respect to possible storage of high-level radioactive waste. | Office of Civilian Radioactive Waste Management |
| Support Arms Control and Treaty Verification Activities | Fulfill U.S. international obligations concerning verification of underground nuclear tests. | Office of Nonproliferation and National Security |
| Other DOE and non-DOE Missions | Various, as described in text. | Various |

respond to certain kinds of national emergencies or situations. The Nuclear Emergency Search Team, a team of highly trained DOE and contractor radiological specialists, can be mobilized in case of accidents involving radioactive materials or a terrorist threat involving nuclear weapons.

The only major new facility for defense program activities is the 100,000 square feet ($ft^2$) Device Assembly Facility. It is located in Area 6, just south of the control point. Because of its multiple processing areas which include assembly cells, assembly bays, high bays, radiographic facilities, special nuclear materials laboratories, high explosive storage, special nuclear material storage, shipping and receiving areas, and associated administrative and support areas, all aspects of the operations will be handled in this one facility. In addition, the facility provides for increased overall security and permits easier entrance and exit accessibility for the workers during hazardous operations. There will be no manufacturing of special nuclear material at this facility.

**Environmental Management Activities.** There are active radioactive and mixed waste disposal areas onsite in Areas 3 and 5. The only major environmental management facility anticipated for the NTS is a waste management facility to handle TRU wastes. A major program to characterize the groundwater at NTS is in progress to determine regional flow paths and rates, and to detect any migration of contamination from past nuclear testing.

**Other Department of Energy Activities.** Although the principal activity at NTS has been the underground testing of nuclear devices, DOE is also involved in a number of other activities. These include the Yucca Mountain waste storage program, liquified gaseous fuel spill tests, and explosive pulsed power experiments.

A high-level radioactive waste facility at nearby Yucca Mountain is under study. The Yucca Mountain high-level radioactive waste facility is handled by the Yucca Mountain Site Characterization Office, which reports directly to the Office of Civilian Radioactive Waste Management. However, because it is based at NTS, the Nevada Operations Office provides some administrative support services to the project.

The Liquified Gaseous Fuel Test Facility in Area 5 was completed in 1986. It is operated on a fee basis for commercial users as a basic research tool for studying the dynamics of accidental releases of hazardous materials and to evaluate the effectiveness of various foams and fire retardants in accidents involving chemicals and hazardous materials.

The Scylla Facility is a proposed explosive pulsed power facility to be located in Area 26. Three

buildings once used as the Pluto Test Cell were proposed for use for the Scylla Facility where experiments in explosive pulsed power would be conducted by Los Alamos National Laboratory.

**Non-Department of Energy Activities.** The main non-DOE activity at NTS was the Defense Nuclear Agency's use of the site as a nuclear weapons effects testing facility. Weapons effects tests were conducted to study a number of nuclear effects including X-rays, gamma rays, neutrons, electromagnetic pulse, air blast, ground and water shock, propagation, and temperature. These tests assessed military systems in a nuclear environment. Various other military exercises and training activities are also carried out at NTS.

**Environmental Regulatory Setting.** The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at NTS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. A brief description of the environmental regulatory setting at NTS follows. This is described in more detail in appendix section A.1.2.

The State of Nevada has regulatory authority for air, water, solid waste, and hazardous waste. A Memorandum of Understanding between DOE and the State of Nevada covers radiological releases on NTS and required notifications. Releases to the NTS environment may originate from tunnels, underground test event sites, and facilities where materials are used, processed, stored, or discharged. DOE and the State of Nevada signed an Agreement in Principle in October 1990 to provide DOE funding to Nevada for oversight of environment, safety, and health (ES&H) activities, including environmental restoration activities at NTS. The Agreement in Principle provides the understanding between and commitment of the parties regarding DOE's provision to the State for technical and financial support in return for environmental oversight and monitoring.

Liquid discharges at NTS are primarily the result of equipment cleaning and sanitary wastes. Discharges also result from groundwater seeping into the tunnels in Rainier Mesa, which have now been sealed. Periodic large discharges to lined sumps occur during characterization well drilling, development, and testing. These discharges are done in accordance with a draft fluid management plan being developed in consultation with the State of Nevada. Water monitoring at NTS is limited to sampling wastewater flowing into lagoons and ponds under a series of permits issued by the State of Nevada.

In 1987, a DOE Headquarters task force determined that underground nuclear device testing areas are subject to the provisions of CERCLA. Under CERCLA, all releases of hazardous or extremely hazardous substances that exceed reportable quantities must be reported to the National Response Center. Soils contaminated by plutonium and other radioactive contaminants are the major concern for NTS. Preliminary Assessment/Site Investigation reports required by CERCLA were prepared for NTS and provided to EPA in 1988. In 1992, a revised Hazard Ranking System package was provided to EPA. EPA will consider the results derived from the revised Hazard Ranking System to determine if any NTS sites are to be included on the NPL. The State of Nevada and DOE are in the process of negotiating a two-party agreement for environmental restoration pursuant to the State's corrective actions regulations.

The Hazardous Waste Accumulation site on NTS is used to collect hazardous wastes prior to shipping offsite to a RCRA-permitted commercial hazardous waste disposal facility. RCRA waste does not stay at NTS for more than 90 days. In May 1990, mixed waste disposal operations were discontinued in compliance with the Land Disposal Restrictions of the Hazardous and Solid Waste Amendment of 1984. Mixed waste disposal operations of offsite generated waste at NTS will not resume until issuance of a State of Nevada RCRA Part B permit.

### 3.3.4 Oak Ridge Reservation

ORR covers approximately 35,000 acres. It includes the following three major facilities: Oak Ridge National Laboratory; Y-12 Plant, ORR (Y-12); and Oak Ridge K-25 Site (K-25). Oak Ridge National Laboratory missions include basic and applied scien-

tific research and technology development. Y-12 engages in national security activities and manufacturing outreach to U.S. industry. K-25, the former gaseous diffusion plant, now serves as an operations center for environmental restoration and waste management programs.

Y-12 was constructed as part of the World War II Manhattan Project. The first site mission was the separation of U-235 from natural uranium by electromagnetic separation. The magnetic separators were taken out of commission at the end of 1946, when gaseous diffusion became the accepted process for enriching uranium. Missions have evolved and changed with the easing of international tensions and resulting conclusion of Y-12's weapon component production mission.

In the near term, the operational space at Y-12 will be significantly downsized in response to reduced workloads. Y-12 is designated as the single interim DOE repository for both unirradiated enriched uranium not required for program use and unirradiated depleted uranium. Present interim storage space will be expanded to accommodate additional enriched uranium returned from stockpiled weapons and other DOE sites. The current missions and functions are described in table 3.3.4–1.

**Defense Program Activities.** The five Y-12 defense program assignments include maintaining the capability to fabricate components (primarily uranium and lithium) for nuclear weapons, storing uranium and lithium materials and parts, dismantling nuclear weapon components returned from the national stockpile, processing special nuclear materials, and providing special production support to the DOE design agencies and other DOE programs.

**TABLE 3.3.4–1.—*Current Missions at Oak Ridge Reservation***

| Mission | Description | Sponsor |
|---|---|---|
| Weapons Components | Maintain capability to fabricate uranium and lithium components and parts for nuclear weapons. | Assistant Secretary for Defense Programs |
| Uranium and Lithium Storage | Store enriched uranium, depleted uranium, and lithium materials and parts. | Assistant Secretary for Defense Programs |
| Dismantlement Activities | Dismantle nuclear weapon components returned from the stockpile. | Assistant Secretary for Defense Programs |
| Special Nuclear Material | Process uranium. | Assistant Secretary for Defense Programs |
| Support Services | Provide support to design agencies as requested. | Assistant Secretary for Defense Programs |
| Environmental Restoration and Waste Management | Waste Management and D&D activities at Oak Ridge National Laboratory, Y-12, and K-25. | Assistant Secretary for Environmental Management |
| Research and Development | Oak Ridge National Laboratory basic research and development in energy, health, and environment. | Office of Energy Research; Assistant Secretary for Environment, Safety and Health; Office of Nuclear Energy |
| Isotope Production | Oak Ridge National Laboratory produces radioactive and stable isotopes not available elsewhere. | Office of Nuclear Energy |
| Educational and Research Programs | Oak Ridge Institute for Science and Education programs in the areas of health, environment, and energy. | Office of Energy Research; Assistant Secretary for Environment, Safety and Health; Office of Nuclear Energy |
| Work for other Federal Agencies | Projects to support other Federal programs. | Department of Energy |
| Technology Transfer | Programs to transfer unique technologies developed at ORR to private industry. | Department of Energy |
| Meteorological Research | Meteorological and atmospheric diffusion research. | National Oceanic and Atmospheric Administration |

Historically, Y-12's primary mission has been to fabricate and assemble uranium (enriched and depleted) and lithium components and other specialty compounds in support of the nuclear weapons stockpile. While unprecedented changes in the world are resulting in nuclear disarmament and reduced nuclear weapons stockpiles, Y-12 continues to maintain the capability to fabricate nuclear weapon components as a major mission. Maintaining production capability involves the ability to fabricate materials into components, inspect and certify the components, and produce subassemblies from components.

As nuclear weapons are removed from the stockpile, these returned weapons must be dismantled, and materials and parts appropriately dispositioned. These returned materials and components, as well as those currently located at Y-12, must be safely and securely placed in short-term or long-term storage. Prior to storage, some processing of special nuclear materials must be performed to recover materials from the returned weapons.

Y-12 also provides fabrication support to DOE's weapon design laboratories at Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories, New Mexico. Y-12 produces components for design evaluation for these customers. In addition, Y-12 performs some stockpile surveillance activities to ensure reliability of the nuclear stockpile.

**Environmental Management Activities.** Environmental management activities are currently planned or in progress at each major functional area on ORR. These activities are summarized below.

*K-25.* The site D&D program will continue to perform Phase I activities including the removal of hazardous materials, utilities, ventilation, lubrication, and cooling systems from the buildings until 1998. In addition, uranium deposits will be removed from process equipment; buildings will be characterized for radiological contamination; and pilot-scale projects will be implemented to test and evaluate technologies before full-scale decontamination, dismantlement, and demolition of the buildings take place. DOE's only TSCA mixed waste incinerator is located at K-25.

Within the environmental restoration program, site assessments will continue to be the focus through 1998. Investigations will proceed according to priorities based on risks to human health and the environment. In addition, ongoing remediation work will continue and interim corrective actions will be initiated as needed.

*Oak Ridge National Laboratory.* The primary outlook for waste management activities at Oak Ridge National Laboratory is to provide waste treatment, storage, and disposal support to DOE's research and development programs. Among areas of emphasis will be increased attention to waste reduction activities, full implementation of waste certification and characterization programs for all waste types, and continued improvement of facility operations through routine maintenance, operator training, and facility upgrades and involvement of private industry capabilities.

Remedial action is proceeding in 12 of 20 regions known as waste area groupings. These 12 waste area groupings contain about 222 sites of contamination. Current activity is focused upon actions which address conditions with potential for affecting human health and the environment.

*Y-12.* Waste management activities at Y-12 continue to treat, store, and dispose of waste generated by defense program activities and other resident programs. The decreasing amount of waste generated by defense production at Y-12 is expected to be offset by waste from weapon dismantlement activities, while the volume of waste from environmental restoration and D&D activities will significantly increase. Environmental management activities are discussed in detail in section 4.4.2.10 and in appendix H.

**Other Department of Energy Activities.** Other DOE activities conducted at ORR include missions and programs of K-25, Oak Ridge National Laboratory, Y-12, nondefense program missions, and the Oak Ridge Institute for Science and Education.

K-25, formerly the Oak Ridge Gaseous Diffusion Plant, serves as the operations center for the management and operations contractor's programs. K-25 also houses DOE's Center for Environmental Technology and Center for Waste Management. Missions

include activities in technology development; technology transfer; engineering technology; uranium enrichment support; and engineering, computing, and telecommunications.

Oak Ridge National Laboratory supports DOE activities in energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education. Oak Ridge National Laboratory also supplies radioactive and stable isotopes that are not available from the private sector.

In addition to the defense program activities described above, Y-12 provides support to Oak Ridge National Laboratory and other government agencies for processing source materials. The Oak Ridge Institute for Science and Education's primary missions are to provide educational and research programs in the areas of health, environment, and energy for DOE, other Federal agencies, and private industry.

**Non-Department of Energy Activities.** At present, the only non-DOE activity at ORR is the ongoing meteorological and atmospheric diffusion research work at the National Oceanic and Atmospheric Administration Atmospheric Turbulence and Diffusion Laboratory. This facility also provides services to DOE contractors and operates the Weather Instrument Telemonitoring Monitoring System for DOE. The site also provides support for Department of Defense programs as needed.

**Environmental Regulatory Setting.** The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. A brief description of the environmental regulatory setting at ORR follows. More detail is available in appendix section A.1.3.

The State of Tennessee has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste (hazardous component only). DOE and the State of Tennessee have signed a Monitoring and Oversight Agreement intended to assure Tennessee citizens that their health, safety, and environment are being protected during ORR facility operations. Under this agreement, DOE will provide financial support to allow the State of Tennessee to carry out its commitment under the Oversight Agreement and the Federal Facility Agreement regarding cleanup activities.

EPA placed ORR on the NPL on December 21, 1989. To satisfy the requirement for an interagency agreement, DOE, EPA Region IV, and the State of Tennessee completed a Federal Facility Agreement effective January 1, 1992.

On March 26, 1993, EPA Region IV certified that DOE had completed all of the actions required by the ORR Radionuclide National Emissions Standards for Hazardous Air Pollutants (NESHAP) Federal Facility Compliance Agreement that they entered into on October 31, 1991. ORR is now considered to be in compliance with the *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H).

Activities are underway to reduce discharges of priority pollutants, high temperature water, and toxic agents such as chlorine to the East Fork Poplar Creek. NPDES permits are required for each ORR facility. A renewed NPDES permit was issued to K-25 on October 1, 1992. The other two ORR sites (Oak Ridge National Laboratory and Y-12) are operating under the provisions of their expired permits while the State of Tennessee acts on the remaining NPDES permit renewals. Oak Ridge National Laboratory submitted a request for modification of its NPDES permit based on evidence that past exceedances of permit limits for total suspended solids, oil, and grease have not impacted watershed water quality. Y-12's NPDES permit public hearing was held in June 1994 and the state continues with the NPDES permit renewal process.

ORR facilities are being operated with a combination of RCRA Part B permits and interim status regulations. The RCRA Part B permit applications have

been submitted for all of the active storage and treatment units listed on the Part A permit. The Federal Facility Compliance Agreement signed by EPA and DOE on June 12, 1992, addresses ORR compliance with the Land Disposal Restrictions of the Hazardous and Solid Waste Amendments of 1984, allowing ORR to continue to operate, and to generate and store mixed wastes. This agreement and subsequent plans would form the basis for the ORR site-specific treatment plan required by the *Federal Facility Compliance Act* of 1992.

TSCA requires that PCB wastes be disposed of within one year of initial storage. However, some PCB wastes are not acceptable to the TSCA incinerator at K-25 and therefore have been stored in excess of one year. On June 11, 1992, DOE formally requested negotiation of a Federal Facility Compliance Agreement with EPA to allow development of a treatment and disposal schedule for ORR's radioactive PCB-contaminated waste and storage or disposal per the Agreement.

### 3.3.5 Pantex Plant

Pantex is located about 17 miles northeast of Amarillo, TX, on approximately 16,000 acres. Pantex was originally constructed by the U.S. Army as a conventional bomb plant early during World War II and was deactivated and vacated after the war. In 1949, Texas Technological College (Texas Tech) purchased the entire site for a token fee of $1 for use in experimental agriculture. However, in 1951, the Atomic Energy Commission asked the Army to "recapture" the main plant and 10,000 surrounding acres for use as a nuclear weapons production facility, at which time the plant was refurbished and expanded. Pantex absorbed the weapons modification functions of the Clarksville, TN, and Medina, TX, plants in 1965 and 1966, respectively. In 1975, Pantex absorbed the functions of the decommissioned Burlington Plant in Iowa. In 1984, an additional 5,800 acres of the original site were leased back from Texas Tech to serve as a security buffer zone between the main plant area and U.S. Highway 60.

Pantex functions include the fabrication of chemical explosives; nuclear weapons assembly, disassembly, testing, quality assurance, repair, and nonnuclear component disposal; and development work in support of the design laboratories. Pantex is the only DOE facility that can execute the final assembly of a nuclear weapon for the DOD stockpile, including the joining of plutonium pits to the chemical explosive main charges to form primary assemblies. In the near term, weapons disassembly and component storage activities will dominate activities at Pantex. Facilities at Pantex will not be downsized or consolidated to a significant degree. Due to ongoing activities to reduce the weapons stockpile, Pantex has developed a capability for sealed pit storage. The present storage capacity is 6,800 units with expansion possible for up to 20,000 units although DOE has agreed to store no more than 12,000 units at Pantex until it completes a site-wide EIS. The current missions and functions are listed in table 3.3.5–1.

**Defense Program Activities.** Almost all activities at Pantex are related to the defense program. Brief descriptions for operations falling under plant missions and functions are provided in the following paragraphs.

High explosive(s) (HE) components production includes: manufacturing main charge subassemblies and mock components for use in weapon test assemblies; manufacturing small HE components; producing a variety of explosive materials from chemical reactants and commercially produced explosives; and evaluating explosive materials and components through a variety of analytical, mechanical, and explosive tests. New production in the context of the Pantex mission is defined as the final assembly of a new nuclear weapon. Pantex receives weapons components and other materials from throughout the DOE Complex and from the U.S. military. Historically, the DOE facilities at SRS, Y-12, the Rocky Flats Environmental Technology Site (formerly known as the Rocky Flats Plant), and the Kansas City Plant have contributed components and subassemblies for use in the final assembly of nuclear weapons. After final assembly, the items produced at Pantex are shipped either to other facilities within the DOE Complex or to military facilities by safe secure trailers.

Modification, maintenance, and repair involves the disassembly of a stockpiled nuclear weapon so that one or more of the components can be repaired, replaced, or modified. After replacing the components, the weapon is reassembled and returned to the

**TABLE 3.3.5–1.—*Current Missions at Pantex Plant***

| Mission | Description | Sponsor |
|---|---|---|
| Plutonium Storage | Provide required plant facility. | Assistant Secretary for Defense Programs |
| High Explosive(s) Components | Manufacture for use in nuclear weapons. | Assistant Secretary for Defense Programs |
| Weapon Assembly | Assemble new nuclear weapons for the stockpile. | Assistant Secretary for Defense Programs |
| Weapon Maintenance | Retrofit, maintain, and repair stockpile weapons. | Assistant Secretary for Defense Programs |
| Quality Assurance | Stockpile quality assurance testing and evaluation. | Assistant Secretary for Defense Programs |
| Weapon Disassembly | Disassemble stockpile weapons as required. | Assistant Secretary for Defense Programs |
| Test/Training Programs | Assemble nuclear weapon-like devices for training. | Assistant Secretary for Defense Programs |
| Weapons Dismantlement | Dismantle nuclear weapons no longer required. | Assistant Secretary for Defense Programs |
| Development Support | Provide support to design agencies as requested. | Assistant Secretary for Defense Programs |
| Support Services | Provide required plant support services. | Assistant Secretary for Defense Programs |
| Waste Management | Provide waste management and D&D activities. | Assistant Secretary for Environmental Management |

stockpile. Pantex also performs many quality assurance evaluation activities on both new and stockpiled nuclear weapons. These tests involve the disassembly of a weapon, the laboratory testing of various components, and the rebuilding of the weapon for shipment back to the stockpile. The plant also disassembles nuclear weapons no longer needed in the stockpile.

In addition to the primary efforts associated with weapons assembly and disassembly, Pantex provides development support and services to the nuclear weapon design agencies and to other government entities as requested. Pantex contains a number of facilities that stage weapon components destined either for the assembly cells or for shipment back to other DOE facilities. Staging procedures may involve the leak testing of staging containers, inventory procedures to verify the number and contents of containers, and unpacking and repacking to physically verify and test contents.

**Environmental Management Activities.** Waste management operations at Pantex in the near term (1996 to 1997) would add facilities to enhance capabilities to adequately handle existing waste streams. New facilities for high explosive incineration and hazardous waste staging, treatment, and storage would be coupled with increased use of commercial offsite facilities to treat mixed waste streams. The long-range outlook (5 to 30 years) indicates increased waste generation as a result of accelerated retirement of the weapons inventory. New waste-handling capacities may be required to meet this need. However, upon completion of the current backlog of dismantlements due to the recent stockpile reductions, this waste generation will decrease. Environmental management activities are discussed in detail in section 4.5.2.10 and in appendix H.

**Environmental Regulatory Setting.** The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at Pantex. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. A brief description of the environmental reg-

ulatory setting at Pantex follows. More detail is available in appendix section A.1.4.

DOE entered into an Agreement in Principle, effective July 31, 1990, with the State of Texas to independently determine and verify any plant operational impacts to the environment. Pursuant to the terms of this agreement, DOE agrees to provide technical and financial support to the state agencies responsible for waste management, environmental monitoring, and emergency response planning at Pantex. DOE will provide the State with a chemical and radiological contaminant inventory and assessment of the plant. The Texas Natural Resources Conservation Commission implemented an environmental monitoring program at Pantex and is providing an independent evaluation of environmental monitoring data. EPA placed Pantex on the NPL on May 31, 1994.

The city of Amarillo operates a major water supply well field immediately north and down gradient of Pantex. Pantex receives its drinking water via five groundwater wells located on the northeast corner of the plant. The water is treated onsite and tested in accordance with requirements for public drinking water systems. The domestic water supply at Pantex meets all of the national primary and secondary drinking water standards for non-community, non-transient public water supply systems. The system is being operated and maintained in compliance with Texas statutes and regulations.

On April 25, 1991, the EPA and the Texas Natural Resources Conservation Commission issued a hazardous waste permit to Pantex to manage hazardous and industrial solid wastes and operate a hazardous waste treatment, storage, and disposal facility. Pantex thermally treats explosive waste and explosive-contaminated waste at the Burning Ground. The hazardous waste permit specifically excluded the 17 RCRA units at the Burning Ground, but continued the interim status of the units which can operate under their "Written Grant of Authority" from the Texas Natural Resources Conservation Commission. In November 1991, DOE formally submitted to the State of Texas a request for a modification to add the units at the Burning Ground to its hazardous waste permit. The State of Texas, DOE, and parties to the hearing process are continuing discussions on terms of the proposed permit modification.

### 3.3.6 Savannah River Site

SRS, located on approximately 192,000 acres near Aiken, SC, became operational in 1953. The major nuclear facilities at SRS have included fuel and target fabrication facilities; nuclear material production reactors; chemical separation plants used for recovery of plutonium and uranium isotopes; a uranium fuel processing area; and the Savannah River Technology Center that provides process support.

Tritium recycling facilities at SRS empty tritium from expired reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs with specification tritium for nuclear stockpile weapons. Filled reservoirs are delivered to Pantex for weapons assembly and directly to DOD as replacements for expired reservoirs. Historically, DOE has produced tritium at SRS. However, DOE has not produced new tritium since 1988. Until a new supply facility is on-line, DOE will not have an assured long-term tritium production capability.

Plutonium and spent nuclear fuel processing at SRS have been terminated. DOE is currently preparing a separate EIS to explore the use of these facilities to stabilize existing quantities of plutonium residues. Tritium recycling operations will continue with the Replacement Tritium Facility conducting the majority of these operations. As part of the nonnuclear consolidation, SRS is also in the process of receiving some of the tritium processing functions currently performed at the Mound Plant in Miamisburg, OH.

The current missions at SRS are shown in table 3.3.6–1. These activities can be categorized as defense program, environmental management, nuclear energy, and other activities.

**Defense Program Activities.** In the past, the SRS complex for the production of nuclear materials consisted of five reactors (the C-, K-, L-, P-, and R-Reactors) in addition to a fuel and target fabrication plant, two target and spent nuclear fuel chemical separation plants, a tritium-target processing facility, a heavy water rework facility, and waste management

**TABLE 3.3.6–1.—*Current Missions at Savannah River Site***

| Mission | Description | Sponsor |
|---|---|---|
| Tritium Recycling | Operate H-Area tritium facilities. | Assistant Secretary for Defense Programs |
| Space Program Support | Provide Pu-238 for space program missions. | Office of Nuclear Energy |
| Interim Plutonium Storage | Operate Plutonium Storage Facility Vault. | Assistant Secretary for Defense Programs |
| Waste Management | Operate waste processing facilities. | Assistant Secretary for Environmental Management |
| Environmental Monitoring and Restoration | Operate remediation facilities. | Assistant Secretary for Environmental Management |
| Process Backlog Targets and Spent Nuclear Fuel | Operate F- and H-Canyons. | Assistant Secretary for Defense Programs |
| Research and Development | Savannah River Technology Center Technical support of DP, EM, and Nuclear Energy programs. | Assistant Secretary for Defense Programs; Assistant Secretary for Environmental Management; Office of Nuclear Energy |
| Other DOE and non-DOE Missions | Various, as described in text. | Various |

facilities. Recently, the K-Reactor, the last operational reactor, was put into cold standby status with no planned provision for restart, thus ending all tritium and special isotope production capability. SRS is conducting tritium-recycling operations in support of stockpile requirements using retired weapons as the tritium supply source.

**Environmental Activities.** Environmental management is pursuing a 30-year plan to achieve full compliance with all applicable laws, regulations, and agreements; treat, store, and dispose of existing waste; reduce generation of new wastes; clean up inactive waste sites; remediate contaminated groundwater; and dispose of surplus facilities. Environmental management activities are discussed in detail in section 4.6.2.10 and appendix H.

**Other Department of Energy Activities.** The Savannah River Technology Center provides technical support to all DOE operations at SRS. In this role, it provides process engineering development to reduce costs, waste generation, and radiation exposure. SRS continues to provide Pu-238 required to support space programs and has an expanding mission to transfer unique technologies developed at the site to industry. SRS is also an active participant in the Strategic Environmental Research and Development Program formulated to develop technologies to mitigate environmental hazards at DOD and DOE sites.

**Non-Department of Energy Activities.** There are several facilities and operations at SRS such as the Savannah River Forest Station, the Savannah River Ecology Laboratory, and the Institute of Archaeology and Anthropology. The Savannah River Forest Station is an administrative unit of the U.S. Forest Service, which provides timber management, research support, soil and water protection, wildlife management, secondary roads management, and fire management to DOE. The Savannah River Forest Station manages 154,000 acres (approximately 80 percent of the site area). It has been responsible for reforestation and manages an active timber business. The Savannah River Forest Station assists with the development and updating of site-wide land use and provides continual support with site layout and vegetative management. It also assists in long-term wildlife management and soil rehabilitation projects.

The Savannah River Ecology Laboratory is operated for DOE by the Institute of Ecology of the University of Georgia. It has established a center of ecological field research where faculty, staff, and students perform interdisciplinary field research and provide an understanding of the impact of energy technologies on the ecosystems of the southeastern United States. This information is communicated to the scientific community, government agencies, and the general public. In addition to Savannah River Ecology Laboratory studies, the Institute of Archaeology and Anthropology is operated by the Univer-

sity of South Carolina to survey the archaeological resources of SRS. This survey is used by DOE when planning new facility additions or modifications, and is referred to in the operations management of the site.

**Environmental Regulatory Setting.** The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. A brief description of the environmental regulatory setting at SRS follows. More detail is available in appendix section A.1.5.

The State of South Carolina has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste. DOE and the State of South Carolina have signed a Memorandum of Agreement whereby SRS agrees to abide by South Carolina environmental laws as any other industry in the state, and will also implement an environmental management plan and report regularly on the progress of that plan.

EPA placed SRS on the NPL effective December 21, 1989. DOE entered into a Federal Facility Agreement effective August 16, 1993 with the EPA and the State of South Carolina to coordinate CERCLA and RCRA cleanups under one comprehensive strategy, which expands the ongoing RCRA Facility Investigation Program. This strategy governs the corrective/remedial action process from site investigation through site remediation, including schedules for producing work plans and facilitating public involvement in decision-making processes.

DOE and EPA entered into the Federal Facility Compliance Agreement for NESHAP on October 31, 1991, allowing SRS to continue operations while installing and certifying additional monitoring and sampling equipment. DOE issued a Letter of Commitment on October 21, 1991, agreeing to redress drinking water system deficiencies. In addition, DOE entered into a Settlement Agreement on February 27, 1990, to satisfy violations of discharging wastewater without a permit.

The Federal Facility Compliance Agreement signed by EPA and DOE on March 13, 1991, addresses SRS compliance with the Land Disposal Restrictions of the Hazardous and Solid Waste Amendments of 1984, allowing SRS to continue to operate, generate, and store mixed wastes. This agreement was amended on April 24, 1992, to include mixed wastes whose treatment standards are outlined in the Land Disposal Restrictions Third Thirds Rule (40 CFR 268.35) and an alternative treatment strategy for M-Area waste. This amended agreement would form the basis for the SRS mixed waste site-specific treatment plan required by the *Federal Facility Compliance Act* of 1992.

TSCA requires PCB wastes to be disposed of within one year of its initial storage. SRS is currently storing radioactive PCB-contaminated equipment and materials past the allowable storage cutoff date. Due to the radioactive nature of these wastes, treatment capability for these wastes is not currently available. DOE is developing this treatment capability and working with South Carolina to approve a treatability study to remove the PCB contamination and return the radioactive materials to SRS as LLW.

## 3.4 TRITIUM SUPPLY TECHNOLOGIES AND RECYCLING

Four tritium supply technologies are being considered in this PEIS: HWR, MHTGR, ALWR, and APT. Each of these would be either collocated with a new tritium recycling facility or use upgraded recycling facilities at SRS. These tritium supply technologies and recycling facilities and their construction, operation, and waste generation data are discussed in the following sections.

### 3.4.1 Background

Tritium, primarily a man-made radioactive isotope of hydrogen, is an essential component of all United States nuclear weapons. Tritium is needed by warheads to ensure that they perform as designed. Because of its radioactive decay, the tritium in the warheads must be periodically replenished. Because it is so rare in nature, all tritium used for weapons and other applications is man-made. However, no new tritium has been produced in the United States since 1988, when all of the tritium-producing reactors at SRS were shut down. Had the Cold War continued, the nuclear weapons stockpile would have quickly run out of tritium if no new tritium were produced. However, because of agreements between the United States and Russia, many nuclear weapons are being removed from the stockpile for dismantlement. This has reduced overall demand for tritium and made more tritium available to support the remaining stockpile. Eventually, however, even this tritium will decay to the point that there will not be enough to meet all nuclear weapons stockpile requirements. A new facility for producing new tritium will be needed early in the next century. The overall tritium supply and recycling complex is depicted in figure 3.4.1–1.

#### 3.4.1.1 *Production of Tritium*

The production of tritium occurs when target materials containing lithium-6 or the gas helium-3 are exposed to neutrons. The subsequent absorption of neutrons by the target atoms causes the target atom to become highly unstable, breaking apart almost instantaneously, leaving tritium as one of the decay products. After neutron bombardment, the target material is removed and the tritium extracted. In the case of the three nuclear reactor technologies analyzed in this PEIS (HWR, MHTGR, and ALWR), neutrons are produced by fission of uranium which has been enriched with U-235. In the case of the proton accelerator, neutrons are produced by the impact of high energy protons in a heavy metal target, such as lead or tungsten. Such a process is called nuclear spallation.

#### 3.4.1.2 *Construction*

Construction of each tritium supply technology would involve heavy construction equipment, such as bulldozers, dump trucks, cranes, concrete trucks, and paving equipment. Construction time would vary from 5 to 9 years, depending upon the tritium supply technology. Heavy duty construction activity would fluctuate during the course of construction. At various times there would be increases in the number of workers, vehicular traffic, and noise.

Construction activity for each of the tritium supply technologies would require a certain amount of onsite clearing and excavation activity for the laying of foundations, the laying of utility cables for electrical systems, and the installation of underground water and sewage systems. Substantial below ground construction would be required for the APT accelerator tunnel and the MHTGR reactor modules.

A construction laydown area would be required for each technology for the purpose of storing raw materials, building supplies, and construction equipment. The size of each laydown area would vary (173 acres to 360 acres), depending on the tritium supply technology, and generally would not exceed the eventual operation area.

#### 3.4.1.3 *Operation*

Although not all of the four technologies use the same methods to produce tritium, they all share common operations facilities. In addition to security, general services, and administrative activities, each technology would require an extraction facility to separate the newly produced tritium from target rods or blankets, a waste treatment facility to process generated waste and a spent nuclear fuel storage area to store used fuel assemblies. A spent fuel storage facility would not be required for the APT because fuel rods are not used in this technology. Additionally, all of the tritium technologies would require a

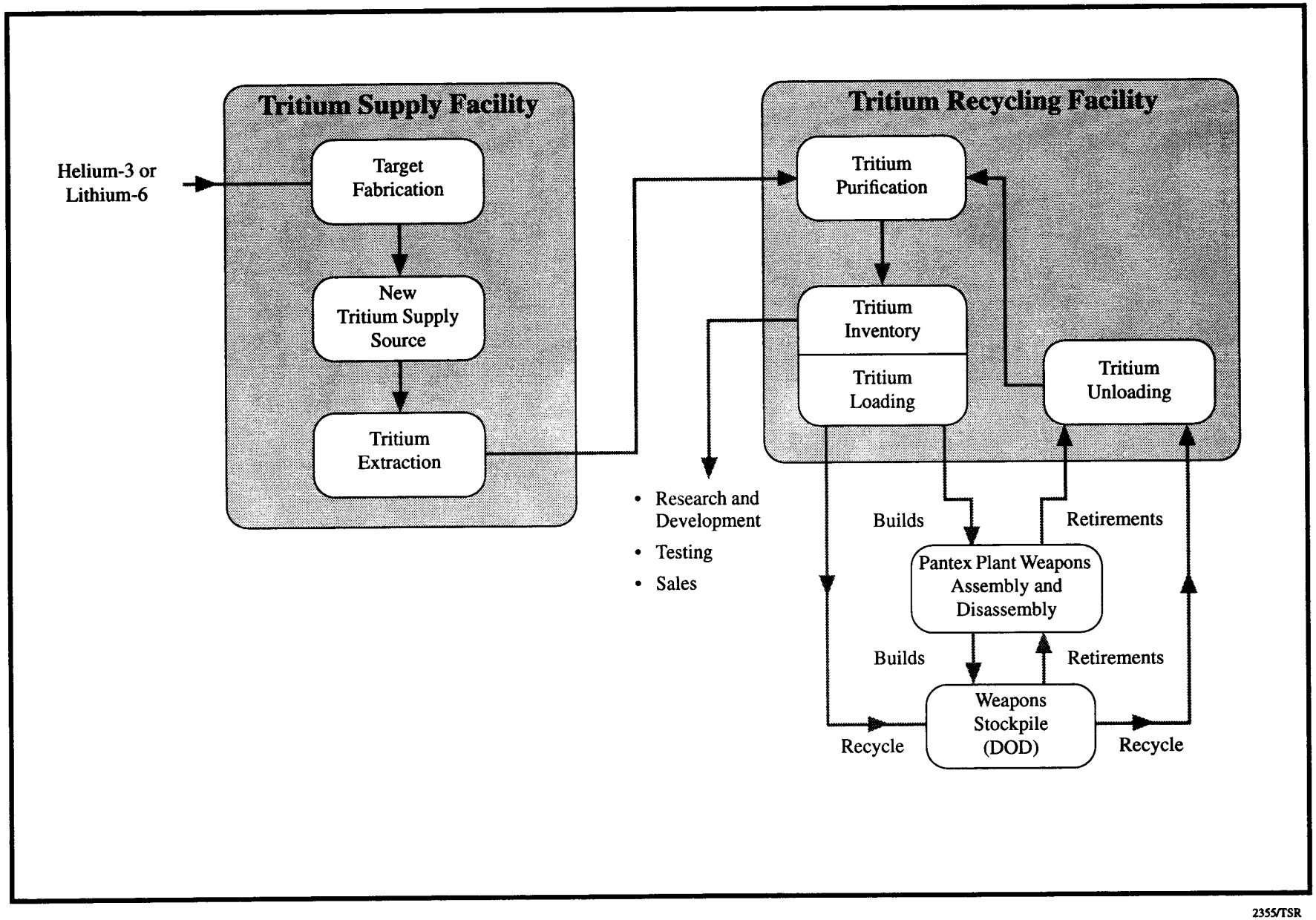



**FIGURE 3.4.1–1.**—*Tritium Supply and Recycling Complex.*

cooling system, an adequate source of water, and in some cases, a cooling basin.

Each of the reactor technologies would require a periodic changing of the fuel and target rods. Target rods or assemblies would be placed in cooling pools for a short period of time to allow decay of short-lived activation products prior to tritium extraction. The targets would then be sent to the tritium extraction facility where the tritium would be extracted from the irradiated target rods or blankets, purified, and sent to the recycling facility where it would be used to fill tritium reservoirs for weapons. The accelerator would require removal or replacement of the target material depending on the target system chosen. The recycling facility would also take reservoirs returned from the stockpile, empty them, and purify the tritium for reuse in new reservoirs.

Operation for all technologies would require routine maintenance activities such as preventative maintenance and equipment repair, which are found in any industrial activity. Each of the technologies would generate LLW such as glove box tools, protective clothing, and HEPA filters; mixed LLW such as rags contaminated with solvents and oils; hazardous wastes, including cleaning solvents and vacuum pump oils; and normal nonhazardous wastes such as sewage and trash. Additionally, the reactor technologies would generate spent nuclear fuel.

#### 3.4.1.4 *Cooling Systems*

Because of the heat generated by nuclear reactors and accelerators, an extensive cooling system would be required to keep them within specified temperature ranges. The heat dissipation system would be dependent on site characteristics. Both wet and dry cooling systems would use water as the heat exchange medium. Wet or dry cooling systems can be used for the reactor technologies considered in this PEIS. As previously described in section 3.1 dry cooling is not a feasible option for the APT technology and wet cooling would be used for it even at dry sites.

In a wet or once-through cooling system, water is drawn continuously at a high rate from an adjacent body of water and circulated through a condenser. This condensor transfers waste heat from the reactor or accelerator to the cooling water, and discharges it back into the body of water. Hence, plants with once-through cooling systems are located only near major rivers, large lakes, or an ocean, where the water supply is adequate. Wet systems would typically use natural draft cooling towers (figure 3.4.2.3–1) and the evaporation process to carry off heat.

Dry systems would typically use water in closed non-evaporative mechanical draft cooling towers (figure 3.4.2.1–1) to carry off heat to the atmosphere by conduction through radiator like vanes with fans to move air over the vanes. There would be some water loss through evaporation in a dry system, but significantly less than with a wet tower. Dry cooling towers would be used for the reactors at all dry sites (e.g., sites with limited or no surface water). In this PEIS the dry sites are considered to be INEL, NTS and Pantex.

Depending on the type of cooling system selected and various other factors such as the climatic conditions at the site, these cooling towers could range from 7 stories for mechanical draft dry cooling towers to 20 to 50 stories for natural draft wet cooling towers. Typically, each unit is made of concrete and circular in shape. Natural draft wet cooling towers must be very tall structures in order to produce sufficient draft to work properly. As a result, natural draft wet cooling towers are more expensive to build than mechanical draft dry cooling towers; however their operating costs are significantly less and the units are much quieter in operation. Mechanical draft dry cooling towers usually consist of a number of individual units. As previously stated, they are less expensive to build than natural towers but more costly to operate. This is reflected in higher utility costs, especially for electricity.

#### 3.4.1.5 *Decontamination and Decommissioning*

D&D activities would be carried out at the end of the facility's life to permit the facility to be removed safely from service and to enable the property to be used for other purposes. The scope of work required for D&D activities can range from performing a simple radiological survey to completely dismantling and removing a radioactively-contaminated facility.

Although D&D activities do not begin until the end of a facility's life, planning for D&D begins in the design phase. All proposed tritium supply technologies and recycling facilities would be designed to

minimize facility equipment contamination and thereby make future D&D of such facilities as simple and inexpensive as feasible, and to minimize the impacts of future D&D, as required by DOE Orders 5820.2A, *Radioactive Waste Management* and 6430.1A, *General Design Criteria.* Further discussion of future D&D requirements is presented in section 4.14. Examples of design features that may be incorporated into tritium supply and recycling facilities to facilitate future D&D are:

- Modular, separable confinements for radioactive and other hazardous materials that preclude contamination of fixed portions of the structure.
- Localized liquid transfer systems that avoid long runs of buried contaminated piping, including special provisions that ensure the integrity of joints in buried pipelines.
- Exhaust filtration components of the ventilation systems at or near individual enclosures to minimize long runs of internally contaminated ductwork.
- Equipment, including effluent decontamination equipment, that precludes the accumulation of radioactive or other hazardous materials in relatively inaccessible areas, including curves and turns in piping and ductwork.
- Easily decontaminated materials that reduce the amount of radioactive and other hazardous materials requiring disposal.
- Designs that ease cutup, dismantlement, removal, and packaging of contaminated equipment from the facility.
- Modular radiation shielding in lieu of or in addition to monolithic shielding walls.
- Lifting lugs on large tanks and equipment.
- Fully drainable piping systems that carry contaminated or potentially contaminated liquids.

### 3.4.2 Tritium Supply Technologies

Of the tritium supply technologies considered by DOE for the production of tritium in this PEIS, only the HWR has tritium production operating experience. The MHTGR and light water reactor (upon which the ALWR is based) technologies have been used in electrical power production but lack tritium production experience and development of tritium target technology. The APT technology, which has an operating history in research and development programs, also has no tritium production experience and only recent development of tritium targets.

Since both the MHTGR and the ALWR were developed originally to produce electricity and as such have steam turbines as an integral part of their designs, this PEIS evaluates the environmental effects of both of these technologies with turbines included. The actual sale of steam or generation of electricity by DOE would be covered in the site-specific tiered NEPA documents if either of these technologies were chosen and DOE developed a proposal to sell steam or generate electricity. The general impacts of the transmission lines necessary to carry this generated electricity are discussed in section 4.8.1. In addition, the general impacts of constructing and operating a dedicated power plant (either coal or natural gas burning) to provide the required power for the APT are also presented in section 4.8.2. As both the MHTGR and the ALWR technologies could also be used for the ultimate disposition of plutonium by burning mixed-oxide fuel, the general impacts of operating these two technologies with mixed-oxide fuel is presented in section 4.8.3.

#### 3.4.2.1 *Heavy Water Reactor*

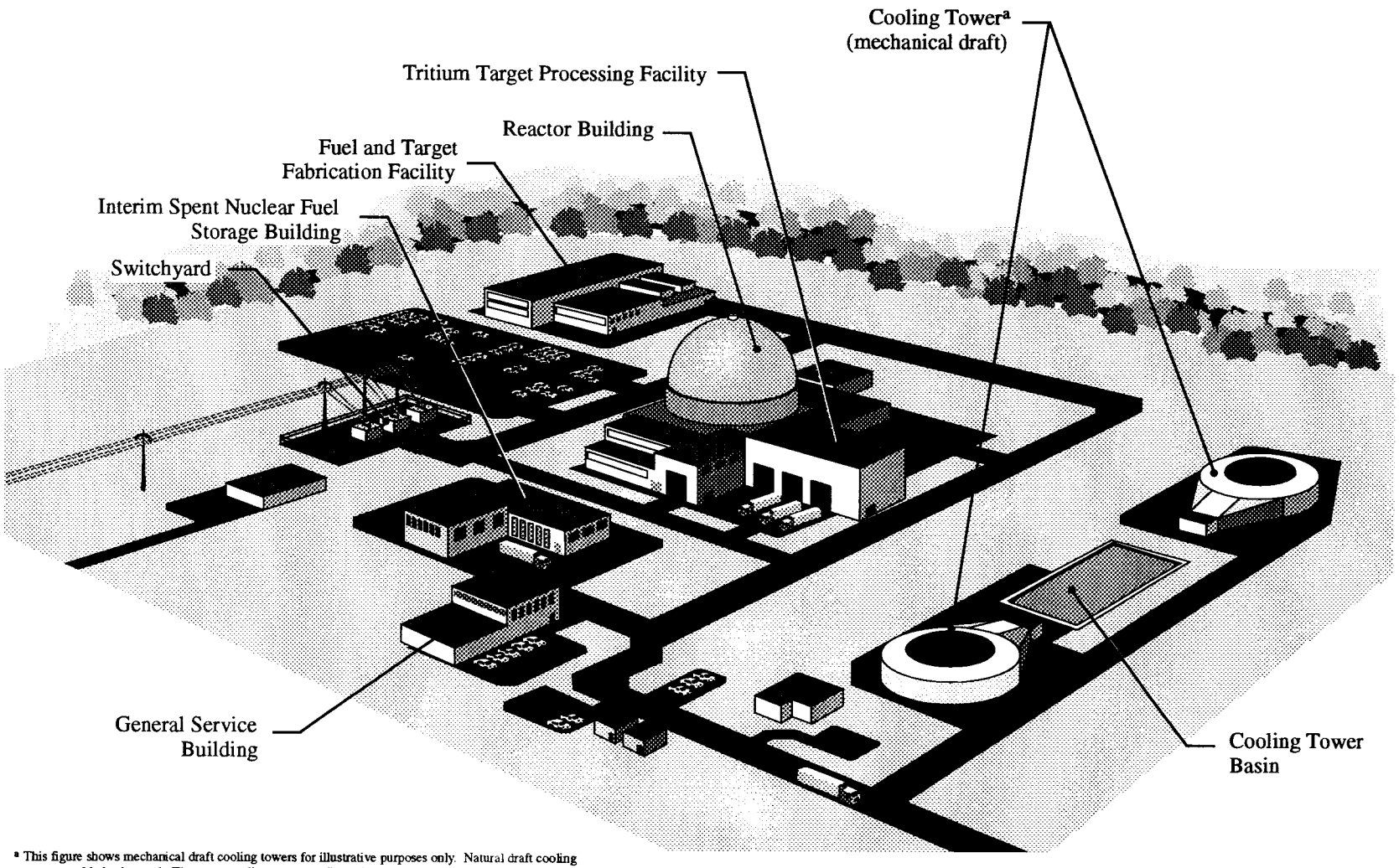
The HWR would be a low pressure, low temperature reactor whose sole purpose would be to produce tritium. A detailed description of the HWR technology and its operation is provided in appendix A. The HWR would use heavy water as the reactor coolant and moderator. Because of the low temperature of the exit coolant, a power conversion system designed to produce electrical power as an option would not be feasible. In addition to the reactor, the HWR complex would consist of several support buildings and other facilities required for the supply and extraction of tritium.

The HWR complex would cover approximately 260 acres and would be surrounded entirely by a security fence. The main reactor would be about 10 stories high and other associated buildings would range from one story to three stories in height. The cooling towers would vary in height, depending on the type of cooling towers utilized. The cooling tower basin, which serves as a holding pond for the cooling towers, would cover approximately 2 acres. In this PEIS dry sites (INEL, NTS, and Pantex) would use mechanical draft dry cooling towers while wet sites (ORR and SRS) would use natural draft wet cooling towers.

The conceptual design of the HWR complex includes a fuel and target fabrication facility to assemble fuel and target rods that are used in the reactor core; a tritium target processing facility to extract and collect tritium from irradiated targets; an interim spent fuel storage building to store used target and fuel rods; a general services building for administrative purposes; and security infrastructure to control access to the complex. Figure 3.4.2.1–1 shows a representative drawing of an HWR complex with mechanical draft cooling towers for illustrative purposes only. The number and arrangement of buildings and support areas are descriptive only and can change significantly as design progresses. The fuel and target fabrication facility would be a steel or concrete structure designed to control the spread of contamination within the building and prevent the uncontrolled release of radioactive material. The target processing facility would consist of two attached structures; a process building and a support building. The process building would include the laboratory, and other activities associated with handling tritium. The support building contains offices, maintenance areas, and nonradioactive ventilation systems.

The design of the HWR would incorporate numerous safety features including: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety related loads in the event of temporary failure of the offsite power supply; a reactor containment building to limit any operational or accidental release of radioactivity, an emergency core cooling system to makeup coolant for heat removal in the event of a loss of coolant or a loss of pumping; an emergency shutdown system with safety rods independent of the reactor control rods; a neutron poison system to inject neutron absorbing material into the moderator tank; and a backup system to remove heat from the reactor if the primary coolant fails to circulate.

Construction of the HWR would take somewhat less than 8 years and require approximately 2,320 workers during the peak construction period. The construction area would be approximately 260 acres. Once constructed, approximately 1 to 2 years would be needed for systems checkout of the reactor prior to actual tritium production. Construction and operation requirements for the HWR are given in tables 3.4.2.1–1 and 3.4.2.1–2. Estimated waste generation data for the HWR facility are given in table 3.4.2.1–3.




[a] This figure shows mechanical draft cooling towers for illustrative purposes only. Natural draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995d.

2297

**FIGURE 3.4.2.1–1.—*Heavy Water Reactor Facility (Typical).***

**TABLE 3.4.2.1–1.—*Heavy Water Reactor Construction Requirements***

| Requirement | Consumption |
|---|---|
| **Material/Resources** | |
| Electrical energy (MWh) | 87,000 |
| Concrete ($yd^3$) | 220,000 |
| Steel (tons) | 45,000 |
| Gasoline, diesel fuel, and lube oil (gal) | 2,400,000 |
| Water (gal) | 170,000,000 |
| **Land disturbance (acres)** | 260 |
| **Employment** | |
| Total employment (worker years) | 9,760 |
| Peak employment (workers) | 2,320 |
| Construction period (years) | 8 |

Source: DOE 1995d.

**TABLE 3.4.2.1–2.—*Heavy Water Reactor Operation Requirements***

| Requirement | Consumption |
|---|---|
| **Electrical Energy (MWh/yr)** | |
| Wet site | 370,000 |
| Dry site | 540,000 |
| **Electrical Load (MWe)** | |
| Wet site | 51 |
| Dry site | 69 |
| **Fuel** | |
| Gas ($ft^3$/yr) | 240,000,000 |
| Liquid (GPY) | 82,000 |
| **Water (MGY)** | |
| Wet site | 5,900 |
| Dry site | 48 |
| **Plant Footprint** | |
| Plant (acres) | 260 |
| **Employment** | |
| Total workers | 930 |
| Badged workers | 230 |

Source: DOE 1995d.

**TABLE 3.4.2.1–3.—*Heavy Water Reactor Estimated Spent Nuclear Fuel and Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Spent Nuclear Fuel** | None | 7 |
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 1,870 |
| **Mixed Low-Level** | | |
| Liquid | None | None |
| Solid | None | 120 |
| **Hazardous** | | |
| Liquid | Included in solid | Included in solid |
| Solid | 20 | 40 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 79,220[a] (16,000,000 gal) | g 238,000[b] (48,000,000 gal) |
| Solid | 7,800 | 2,530 |
| **Nonhazardous (Other)** | | |
| Liquid | 2,570 (520,000 gal) | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Does not include groundwater dewatering, if required.

[b] At a dry site, nonevaporative cooling yields no cooling tower blowdown. At a wet site, the liquid effluent is 11,600,000 $yd^3$ (2,350,000,000 gal).

Source: DOE 1995d.

### 3.4.2.2 *Modular High Temperature Gas-Cooled Reactor*

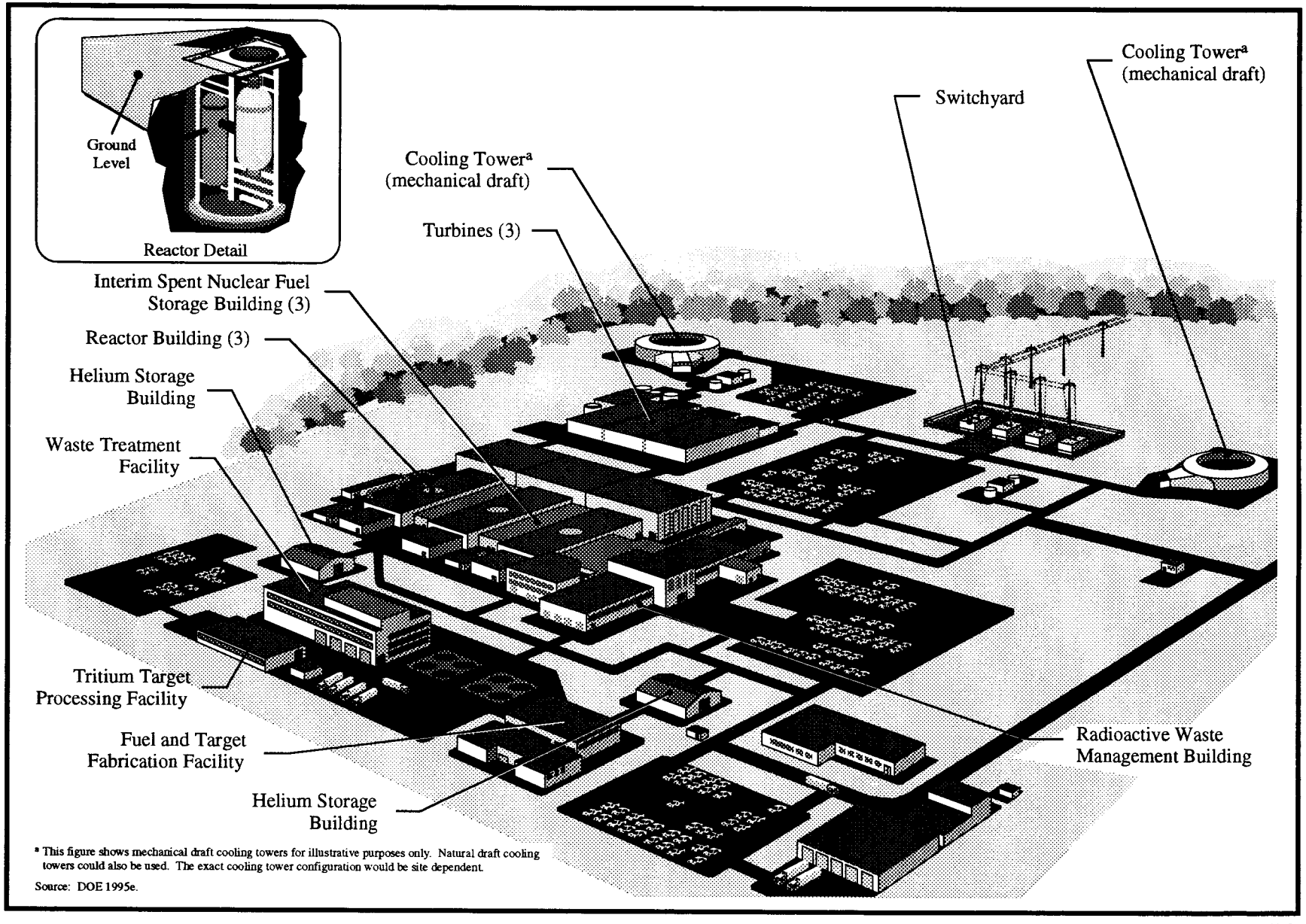
The MHTGR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium. A detailed description of the MHTGR technology and its operation is provided in appendix A. The MHTGR would use helium gas as a core coolant and graphite as a moderator. Because of the high temperature of the exit coolant, a power conversion facility designed to produce electricity is an integral part of the design and will be included in this analysis. In addition to the reactor building and the power conversion building, the MHTGR complex would consist of several buildings and other facilities required for the supply and extraction of tritium.

The MHTGR complex would cover approximately 360 acres and would be surrounded entirely by a security fence. The MHTGR would consist of three 350 MWt reactor vessels housed in adjacent, below-grade, reinforced-concrete silos. The silos would extend approximately 160 feet below-grade and each reactor vessel would be about 22 feet in diameter and 75 feet high. Each reactor vessel would contain a reactor core, reflectors, and associated supports. A shutdown cooling heat exchanger and a shutdown cooling circulator would be located at the bottom of the vessels. Support buildings and other associated facilities within the MHTGR complex would range in height from one to three stories. Two cooling towers would be needed and their height would vary, depending on the type of cooling towers that are utilized. In this PEIS dry sites (INEL, NTS, and Pantex) would use mechanical draft dry cooling towers and wet sites (ORR and SRS) would use natural draft wet cooling towers.

The design of the MHTGR complex would include a fuel and target fabrication facility, a tritium target processing building, helium storage buildings, waste treatment facilities, spent fuel storage facility, a general services building, a security infrastructure, and a power conversion facility consisting of three turbine-generators and associated electrical control equipment. Figure 3.4.2.1–1 shows a representative drawing of a MHTGR complex with mechanical draft cooling towers shown for illustrative purposes only. The number and arrangement of buildings and support areas are descriptive only and can change significantly as design progresses.

The design of the MHTGR would incorporate numerous safety features that include: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety related loads in the event of temporary failure of the offsite power supply; a below-grade design, which serves as a barrier to external hazards (aircraft, turbine blades, and tornado-generated debris), reduces seismic-induced stress on the reactors, and provides radiological shielding; a below-grade containment structure made of reinforced concrete; an emergency core cooling system; and an emergency shutdown system with safety rods independent of the reactor control rods.

Construction of the MHTGR would take about 9 years and require approximately 2,210 workers during the peak construction period. The construction area would be approximately 360 acres. One to two years would be needed after construction for system check-out of the reactor prior to actual tritium production. Construction and operation requirements for the MHTGR are given in tables 3.4.2.2–1 and 3.4.2.2–2. Estimated waste generation data for the MHTGR complex are given in table 3.4.2.2–3.




[a] This figure shows mechanical draft cooling towers for illustrative purposes only. Natural draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995e.

2295

**FIGURE 3.4.2.2–1.—*Modular High Temperature Gas-Cooled Reactor Facility (Typical).***

**TABLE 3.4.2.2–1.—*Modular High Temperature Gas-Cooled Reactor Construction Requirements***

| Requirement | Consumption |
|---|---|
| **Material/Resources** | |
| Electrical energy (MWh) | 73,000 |
| Concrete ($yd^3$) | 220,000 |
| Steel (tons) | 60,000 |
| Gasoline, diesel fuel, and lube oil (gal) | 3,200,000 |
| Water (gal) | 160,000,000 |
| **Land Disturbance (acres)** | 360 |
| **Employment** | |
| Total employment (worker years) | 8,810 |
| Peak employment (workers) | 2,210 |
| Construction period (years) | 9 |

Source: DOE 1995e.

**TABLE 3.4.2.2–2.—*Modular High Temperature Gas-Cooled Reactor Operation Requirements***

| Requirement | Consumption |
|---|---|
| **Electrical Energy (MWh/yr)** | |
| Wet site | 260,000 |
| Dry site | 360,000 |
| **Electrical Load (MWe)** | |
| Wet site | 36 |
| Dry site | 46 |
| **Fuel** | |
| Gas ($ft^3$/yr) | 6,000,000 |
| Liquid (GPY) | 81,000 |
| **Water (MGY)** | |
| Wet site | 4,000 |
| Dry site | 30 |
| **Plant Footprint** | |
| Plant (acres) | 360 |
| **Employment** | |
| Total workers | 910 |
| Badged workers | 180 |

Source: DOE 1995e.

**TABLE 3.4.2.2–3.—*Modular High Temperature Gas-Cooled Reactor Estimated Spent Nuclear Fuel and Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Spent Nuclear Fuel** | None | 80 |
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 468 |
| **Mixed Low-Level** | | |
| Liquid | None | None |
| Solid | None | <1 |
| **Hazardous** | | |
| Liquid | Included in solid | Included in solid |
| Solid | 20 | 100 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 64,400[a] (13,000,000 gal) | 149,000[b] (30,000,000 gal) |
| Solid | 7,100 | 2,470 |
| **Nonhazardous (Other)** | | |
| Liquid | 3,020 (610,000 gal) | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Does not include ground dewatering, if required.

[b] At a dry site nonevaporative cooling yields no cooling tower blowdown. At a wet site the liquid effluent is 8,070,000 $yd^3$ (1,630,000,000 gal).

Source: DOE 1995e.

### 3.4.2.3 *Advanced Light Water Reactor*

The ALWR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium. There are two options for the proposed ALWR technology: a Large ALWR (1100 to 1300 MWe) and a Small ALWR (600 MWe). The large and small options would be chosen from the following four candidates: a large or small pressurized water reactor or a large or small boiling water reactor. A detailed description of the ALWR technology options and their operations is provided in appendix A. All ALWR options would use light (regular) water as the reactor coolant and moderator. Like the MHTGR, a power conversion facility (steam turbine) is an integral part of the design for the ALWR because of the high temperature of the exit coolant and will be included in this analysis. In addition to the reactor building, the ALWR complex would consist of several support buildings and other facilities for the supply and extraction of tritium.

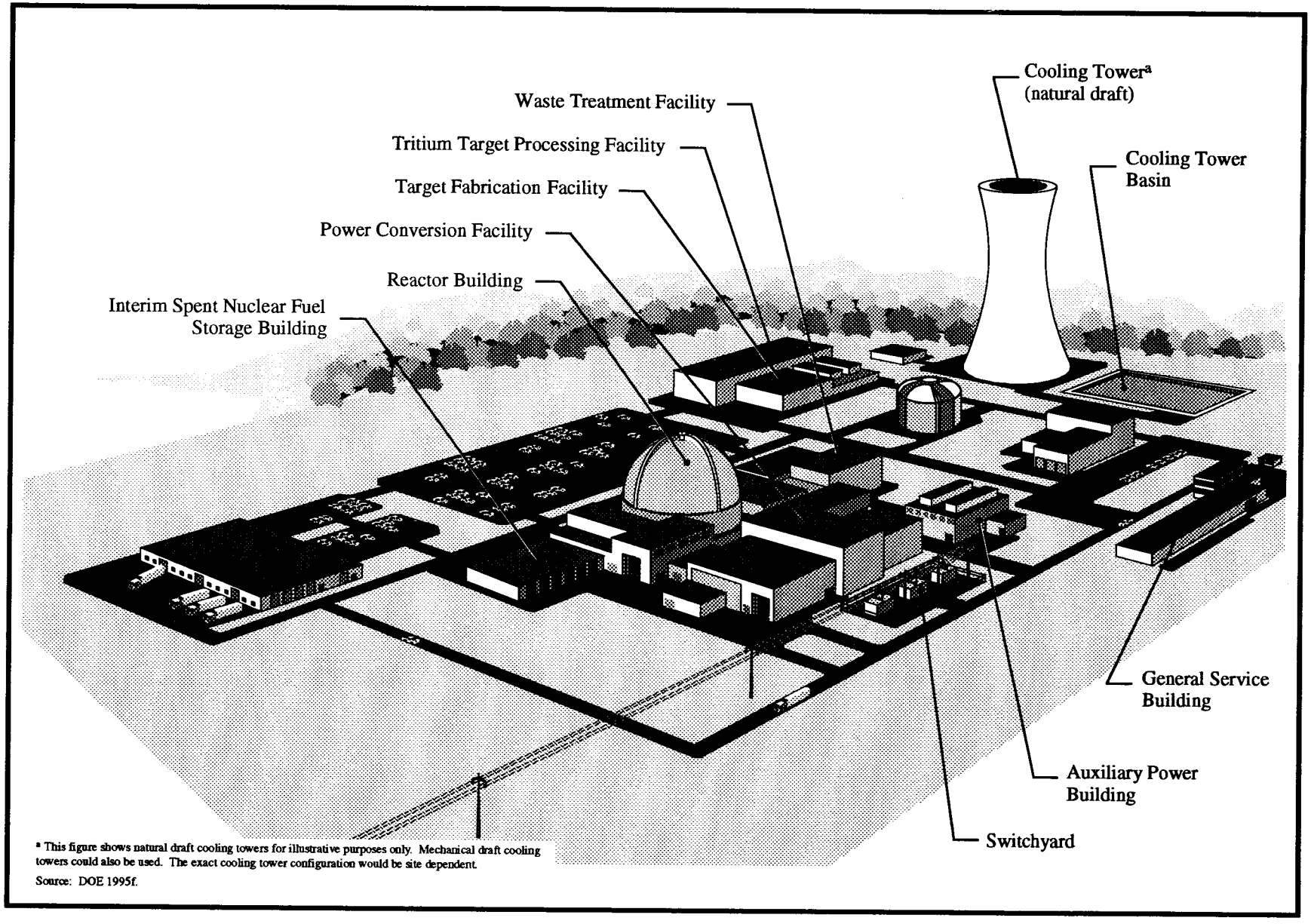
The ALWR would cover approximately 350 acres and the whole complex would be surrounded by a security fence. The main reactor building would be approximately 10 stories high. The other associated buildings would range from one to three stories in height. The differences between the large and small options are primarily in the power output of the reactors. Both of the small reactors are rated at 600 MWe, while the large options are rated at 1,300 MWe. The physical sizes of the large and small options for each of the technologies are generally the same.

In addition to the reactor, the ALWR complex would include an interim spent fuel storage building, a waste treatment facility, a tritium target processing facility, warehouses, and a power conversion facility. Unlike the other technologies, the ALWR would not have a fuel fabrication facility since fuel rods would be obtained from offsite sources. Figure 3.4.2.3–1 shows a representative drawing of an ALWR complex with a natural draft cooling tower shown for illustrative purposes only. The number and arrangements of buildings and support areas are descriptive only and can change significantly as design progresses.

The tritium target processing facility would consist of the following two attached structures: a processing building and a support building. The process building would include the tritium extraction processes, laboratory, and other activities associated with handling tritium. The support building contains offices, maintenance areas, and nonradioactive ventilation systems. The type of cooling tower used depends upon where the ALWR is located. In this PEIS dry sites (INEL, NTS and Pantex) would use mechanical draft dry cooling towers and wet sites (ORR and SRS) would use natural draft wet cooling towers.

The design of the ALWR would incorporate numerous safety features such as: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety related loads in the event of temporary failure of the offsite power supply; a reactor containment building to limit any release of radioactivity; an emergency core cooling system to makeup coolant in the event of a loss of coolant or a loss of pumping; an emergency shutdown system; and a neutron poison system to inject neutron absorbing material into the reactor vessel.

Construction of the ALWR would take about 6 years and require approximately 3,500 workers for the Large ALWR and 2,200 workers for the Small ALWR during the peak construction period. The construction area would be approximately 350 acres. Once constructed, 1 to 2 years would be needed to check out the reactor prior to actual tritium production. Construction and operation requirements for the Large and Small ALWR are given in tables 3.4.2.3–1 and 3.4.2.3–2. Estimated waste generation data for the Large and Small ALWR facility are given in tables 3.4.2.3–3 and 3.4.2.4–4.




[a] This figure shows natural draft cooling towers for illustrative purposes only. Mechanical draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995f.

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**FIGURE 3.4.2.3–1.—*Advanced Light Water Reactor Facility (Typical).***

**TABLE 3.4.2.3–1.—*Advanced Light Water Reactor Construction Requirements***

| Requirement | Consumption | |
|---|---|---|
| | Large ALWR | Small ALWR |
| **Material/Resources** | | |
| Electrical energy (MWh) | 120,000 | 120,000 |
| Concrete ($yd^3$) | 380,000 | 200,000 |
| Steel (tons) | 68,000 | 50,000 |
| Fuel, liquid (gal) | 1,500,000 | 1,500,000 |
| Water (gal) | 200,000,000 | 120,000,000 |
| **Land disturbance (acres)** | 350 | 350 |
| **Employment** | | |
| Total employment (worker years) | 12,600 | 7,100 |
| Peak employment (workers) | 3,500 | 2,200 |
| Construction period (years) | 6 | 6 |

Source: DOE 1995f.

**TABLE 3.4.2.3–2.—*Advanced Light Water Reactor Operation Requirements***

| Requirement | Consumption | |
|---|---|---|
| | Large ALWR | Small ALWR |
| **Electrical Energy (MWh/yr)** | | |
| Wet Site | 700,000 | 380,000 |
| Dry Site | 1,100,000 | 580,000 |
| **Electrical Load (MWe)** | | |
| Wet Site | 96 | 52 |
| Dry Site | 140 | 75 |
| **Fuel** | | |
| Gas ($ft^3$/yr) | 0 | 0 |
| Liquid (GPY) | 200,000 | 110,000 |
| **Water (MGY)** | | |
| Wet site | 16,000 | 7,200 |
| Dry site | 90 | 50 |
| **Plant Footprint** | | |
| Plant (acres) | 350 | 350 |
| **Employment** | | |
| Total workers | 830 | 500 |
| Badged workers | 210 | 125 |

Source: DOE 1995f.

**TABLE 3.4.2.3–3.—*Advanced Light Water Reactor (Large) Estimated Spent Nuclear Fuel and Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Spent Nuclear Fuel** | None | 30 |
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 567 |
| **Mixed Low-Level** | | |
| Liquid | None | None |
| Solid | None | 6 |
| **Hazardous** | | |
| Liquid | Included in solid | Included in solid |
| Solid | 930 | 35 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 134,000[a] (27,000,000 gal) | 446,000[b] (90,000,000 gal) |
| Solid | 15,000 | 2,300 |
| **Nonhazardous (Other)** | | |
| Liquid | 2,480 (500,000 gal) | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Does not include ground dewatering, if required.

[b] At a dry site nonevaporative cooling yields no cooling tower blowdown. At a wet site the liquid effluent is 31,100,000 $yd^3$ (6,290,000,000 gal).

Source: DOE 1995f.

**TABLE 3.4.2.3–4.—*Advanced Light Water Reactor (Small) Estimated Spent Nuclear Fuel and Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Spent Nuclear Fuel** | None | 15 |
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 272 |
| **Mixed Low-Level** | | |
| Liquid | None | None |
| Solid | None | 6 |
| **Hazardous** | | |
| Liquid | Included in solid | Included in solid |
| Solid | 850 | 35 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 74,300[a] (15,000,000 gal) | 248,000[b] (50,000,000 gal) |
| Solid | 10,000 | 1,400 |
| **Nonhazardous (Other)** | | |
| Liquid | 2,480 (500,000 gal) | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Does not include ground dewatering, if required.

[b] At a dry site nonevaporative cooling yields no cooling tower blowdown. At a wet site the liquid effluent is 14,100,000 $yd^3$ (2,850,000,000 gal).

Source: DOE 1995f.

### 3.4.2.4 *Accelerator Production of Tritium*

The APT would be a linear accelerator whose primary purpose would be to produce tritium. A detailed description of the APT technology and its operation is provided in appendix A. The APT accelerates a proton beam in a long tunnel to one of two target/blanket assemblies located in separate target stations. There are two target/blanket concepts being considered in the conceptual design of the full size APT: the helium-3 target and the spallation-induced lithium conversion target. The helium-3 target is the primary target in the Phase APT option.

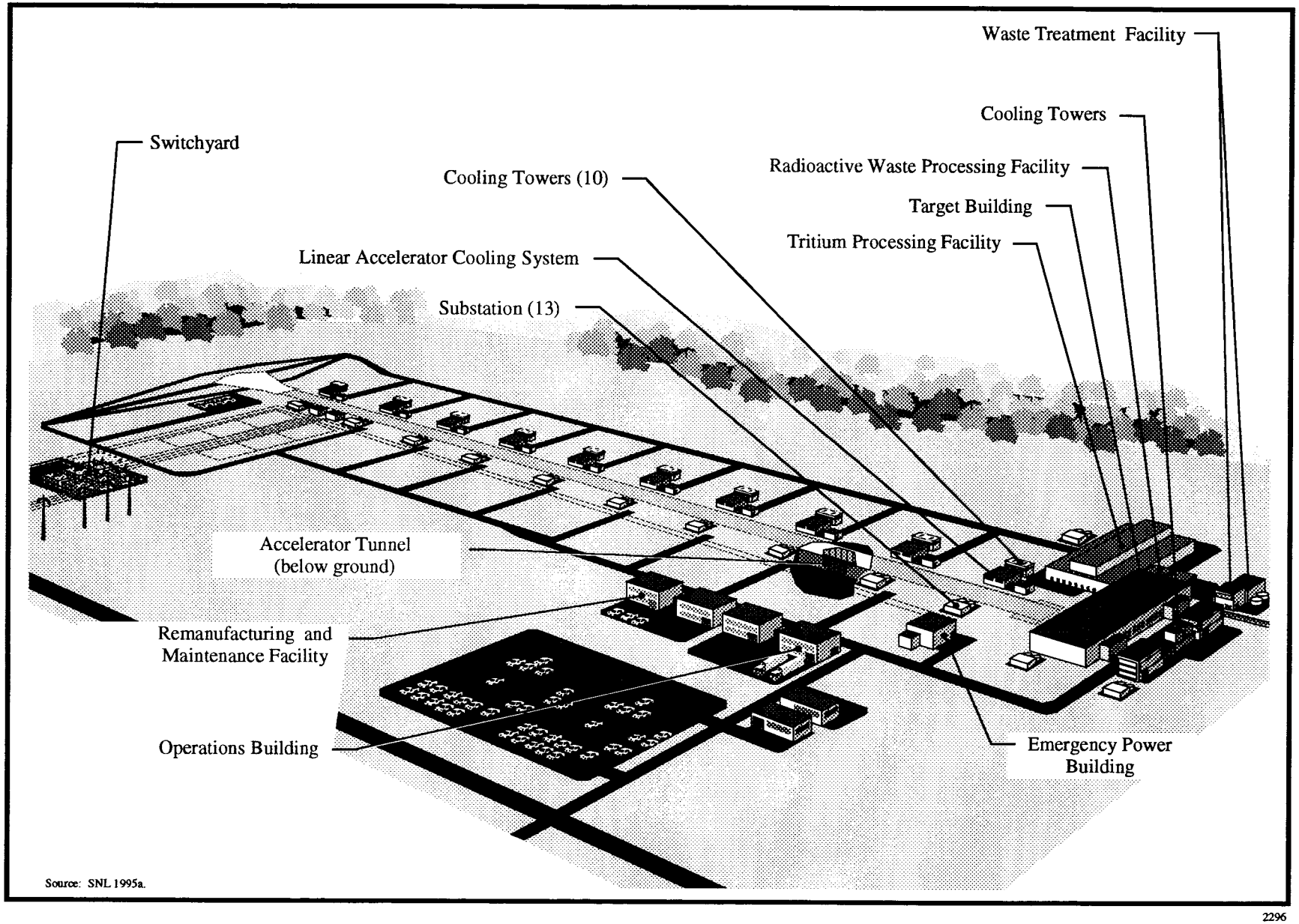
The APT complex would cover approximately 173 acres and would be surrounded entirely by a security fence. The accelerator, 3,940 feet in length, would be housed in a concrete tunnel buried 40 to 50 feet underground for radiation shielding. The design of the APT radio frequency power system and its distribution network is similar to that of existing accelerators for which there are decades of operational experience. The existing accelerators have been shown to pose no appreciable health threat to workers and the public. In addition, there is no appreciable danger of interference with communications or the many signal sensitive electronic systems (LANL 1994a:1). The tunnel would be sealed and evacuated during operation but would vent to the atmosphere during shutdown period. The full size facility would consist of 10 cooling towers and 13 substations located above-ground along the full length of the underground accelerator. Additionally, there would be two cooling towers for the target/blanket beam stop, located next to the target building. The cooling towers and the substations would be approximately one to two stories in height.

The preconceptual design of the APT complex includes: a target building that would house either the helium-3 or the spallation-induced lithium conversion target chambers located in a subterranean structure at the same level as the accelerator; a tritium processing facility to extract tritium from the targets; a klystron remanufacturing and maintenance facility; waste treatment buildings to treat all generated wastes; and various administration, operation, and maintenance facilities. Figure 3.4.2.4–1 shows a representative drawing of a APT complex. The number and arrangement of buildings and support areas are illustrative only and can change significantly once as design progresses.

The design of the APT would incorporate numerous safety features to include: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety related loads in the event of temporary failure of the offsite power supply; multiple sensors and diagnostics which would determine if the accelerator beam is out of acceptable limits in terms of position, energy, size, etc.; redundant cooling systems for all heat-removal systems; and an automatic beam shutoff in the event of a loss of cooling, a misaligned beam, or abnormal radiation levels.

Construction of the APT would take about 5 years and require approximately 1,350 workers during the peak construction period. Additional construction area for equipment and materials would not be required since there would be sufficient unencumbered space within the APT boundaries. Once constructed, 1 to 2 years would be needed to check out the accelerator prior to actual tritium production.

If desired, a phased construction of the APT could also occur. Under this scenario, initial construction of the APT would complete the majority of the civil engineering and would result in a facility that could produce the steady-state requirement (approximately 50 percent of baseline case). Expansion of the facility could be possible at a later date in order to increase tritium production to the baseline requirements if necessary. This expansion would consist of the addition of another injector leg, a funnel to combine its proton beam with the other, and additional radio frequency power sources to accelerate it. All tables display requirements for both a full production APT and a phased approach to the construction of an APT. Construction and operation requirements for the APT are given in tables 3.4.2.4–1 and 3.4.2.4–2. Estimated waste generation data for the APT complex are given in tables 3.4.2.3–3 and 3.4.2.3–3.




Source: SNL 1995a.

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**FIGURE 3.4.2.4–1.—*Accelerator Production of Tritium Facility Site Layout (Typical).***

**TABLE 3.4.2.4–1.—*Accelerator Production of Tritium Construction Requirements***

| Requirement | Consumption | |
|---|---|---|
| | Full APT | Phased APT |
| **Material/Resources** | | |
| Electrical energy (MWh) | 40,000 | 40,000 |
| Concrete ($yd^3$) | 275,000 | 275,000 |
| Steel (tons) | 61,495 | 55,820 |
| Gasoline, diesel fuel, and lube oil (gal) | 2,110,000 | 2,110,000 |
| Water (gal) | 41,700,000 | 41,700,000 |
| **Land Disturbance (acres)** | 173 | 173 |
| **Employment** | | |
| Total employment (worker years) | 3,440 | 3,440 |
| Peak employment (workers) | 1,350 | 1,350 |
| Construction period (years) | 5 | 5 |

Source: SNL 1995a.

**TABLE 3.4.2.4–2.—*Accelerator Production of Tritium Operation Requirements***

| Requirement | Consumption (Wet and Dry Sites) | |
|---|---|---|
| | Full APT | Phased APT |
| **Electrical Energy (MWh/yr)** | 3,740,000 | 2,400,000 |
| **Electrical Load (MWe)** | 550 | 355 |
| **Fuel** | | |
| Gas ($ft^3$/yr) | 0 | 0 |
| Liquid (GPY) | 13,200 | 13,200 |
| **Water (MGY)** | 2,642 | 1,691 |
| **Plant Footprint** | | |
| Plant (acres) | 173 | 173 |
| **Employment** | | |
| Total workers | 624 | 624 |
| Badged workers | 258 | 258 |

Source: SNL 1995a.

**TABLE 3.4.2.4–3.—*Accelerator Production of Tritium (Full) Estimated Waste Volumes***

| Waste Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$)[a] |
|---|---|---|
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 221 |
| **Mixed Low-Level** | | |
| Liquid | None | None |
| Solid | None | 3.9 |
| **Hazardous** | | |
| Liquid | Included in solid | 0.003 (0.6 gal) |
| Solid | 13 | 2.5 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 1,570[b] (317,000 gal) | <1,000[c] (<200,000 gal) |
| Solid | 5,500 | 413 |
| **Nonhazardous (Other)** | | |
| Liquid | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None |

[a] The full APT waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target waste volumes are approximately the same with the exception of solid LLW which is 57 $yd^3$.

[b] Does not include ground dewatering, if required.

[c] At a dry site the treated effluent from blowdown and sanitary wastewater treatment are recycled for reuse as cooling water makeup and other services after treatment. At a wet site the effluent is 1,990,000 $yd^3$ (401,000,000 gal).

Source: SNL 1995a.

**TABLE 3.4.2.4–4.—*Accelerator Production of Tritium (Phased) Estimated Waste Volumes***

| Waste Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$)[a] |
|---|---|---|
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 54 |
| **Mixed Low-Level** | | |
| Liquid | None | None |
| Solid | None | 2.5 |
| **Hazardous** | | |
| Liquid | Included in solid | 0.0003 (0.06gal) |
| Solid | 13 | 1.2 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 1,570[b] (317,000 gal) | <1,000[c] (<200,000 gal) |
| Solid | 5,500 | 413 |
| **Nonhazardous (Other)** | | |
| Liquid | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Waste volumes based on helium-3 target.

[b] Does not include ground dewatering, if required.

[c] At a dry site the treated effluent from blowdown and sanitary wastewater treatment are recycled for reuse as cooling water makeup and other services after treatment. At a wet site the effluent is 1,990,000 $yd^3$ (401,000,000 gal).

Source: SNL 1995a.

### 3.4.3 Tritium Recycling

The primary mission of the tritium recycling facility is to process and recycle tritium for use in nuclear weapons. This mission includes the steps necessary to empty reservoirs (small pressure vessels containing tritium installed in nuclear weapons), recover the tritium, provide new gas mixtures according to specifications, and reclaim usable reservoirs. Additionally, the tritium recycling facility would perform a full range of analytical, physical, and environmental tests to ensure that the quality and integrity of all reservoirs are maintained throughout their operational life. It would also provide for appropriate waste management, including storage, treatment, and disposal of tritiated wastes.

The tritium recycling facility would receive tritium in reservoirs returned from DOD and other activities, or as virgin tritium from the extraction facility that is associated with the tritium supply facility. The reservoirs would be unpacked from their shipping containers in the auxiliary building and taken to the tritium processing building for temporary storage. They would then be emptied and the contained gases would be processed to separate the hydrogen isotopes from other gases, primarily helium-3 (a stable isotope resulting from the radioactive decay of tritium). Prior to being placed into reservoirs, the tritium would undergo a purification process. The empty reservoir bottles would be sent to the tritium auxiliary building to be reclaimed. If reclamation is not possible, the bottles would be disposed of as LLW. Otherwise, they would be refurbished and sent to the tritium processing building to be filled.

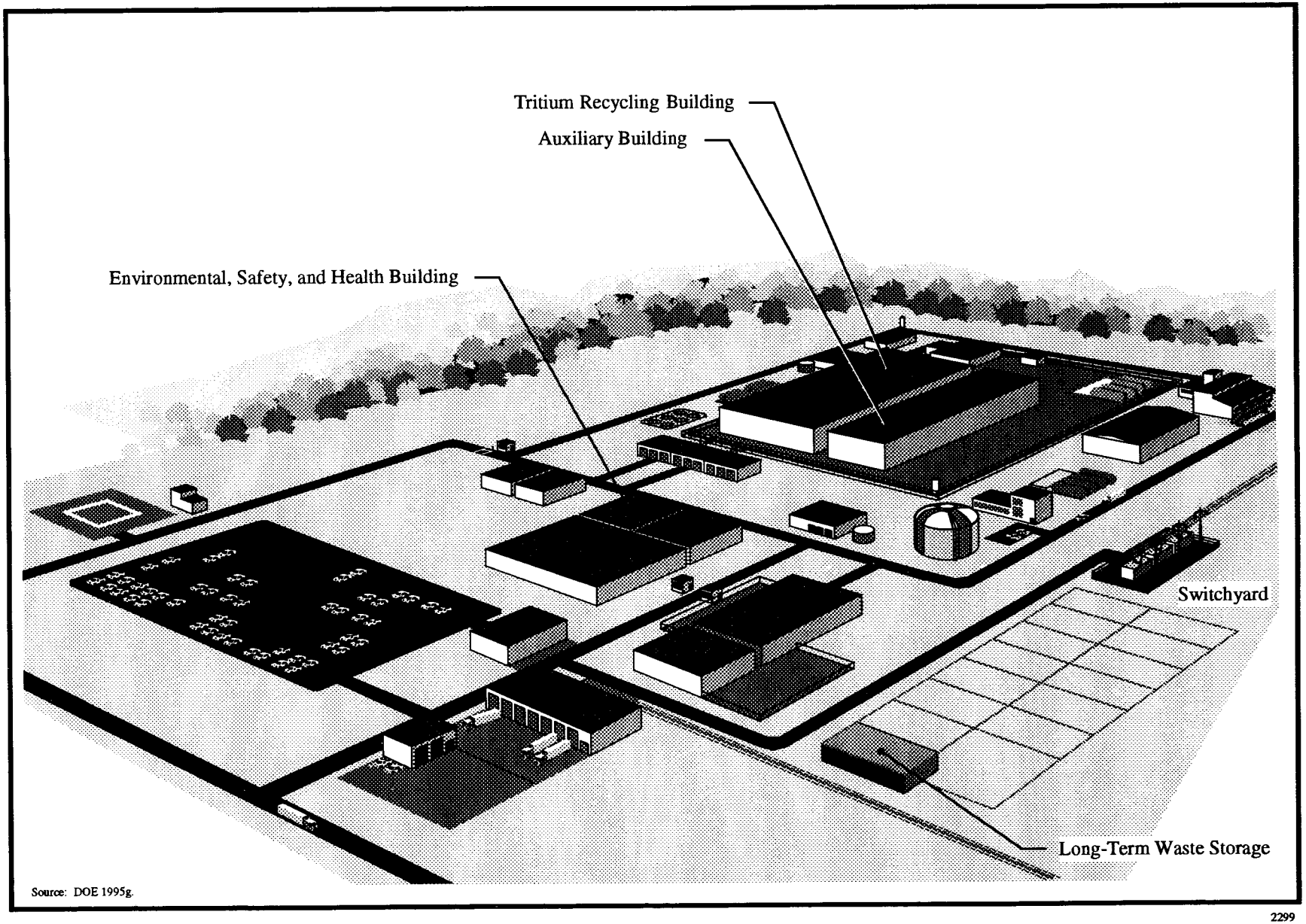
Reservoirs that have been filled with tritium and sealed would be transferred to the auxiliary building for finishing, where they would be decontaminated, leak tested, inspected, marked, measured for tritium content, and if required, combined with various piece parts necessary for final assembly. The reservoirs would then be placed in storage until they are needed for limited life component exchange, or sent to the assembly and disassembly facility for use in new weapons.

Some reservoirs would be placed in the weapon surveillance program. The tritium recycling facility would include testing capability for production, surveillance, and research and development reservoirs. In general, tests on reservoirs filled with tritium would be performed in the tritium processing building, while tests on other bottles or parts of bottles would be performed in the auxiliary building.

Tritium recycling could be collocated with tritium supply, or be done in existing facilities at SRS. At SRS, an upgrade of the existing recycling facilities would be implemented rather than construction of a new facility. Discussed below are the options for new or upgraded recycling facilities.

#### 3.4.3.1 *New Recycling Facility*

If the tritium supply and recycling facilities are located at any site other than SRS, a new recycling facility would have to be constructed (figure 3.4.3.1–1). The tritium recycling facility would be housed in two major buildings and in several support facilities. The first building, the tritium processing building, would be a hardened facility designed with systems to contain tritium releases should they occur. The second building, the auxiliary building, would house non-tritium and extremely small amounts of working tritium. These buildings would be located within a 202-acre plant area. Construction, operation, and waste generation data for the new tritium recycling facility are presented in tables 3.4.3.1–1, 3.4.3.1–2, and 3.4.3.1–3, respectively.




Source: DOE 1995g.

2299

**FIGURE 3.4.3.1–1.—*New Tritium Recycling Facility (Typical).***

**TABLE 3.4.3.1–1.—*New Tritium Recycling Facility Construction Requirements***

| Requirement | Consumption |
|---|---|
| **Material/Resources** | |
| Electrical energy (MWh) | 10,000 |
| Concrete ($yd^3$) | 32,000 |
| Steel (tons) | 5,600 |
| Gasoline, diesel fuel, and lube oil (gal) | 260,000 |
| Water (gal) | 6,100,000 |
| **Land Disturbance (acres)** | 202 |
| **Employment** | |
| Total employment (worker years) | 992 |
| Peak employment (workers) | 335 |
| Construction Period (years) | 4 |

Source: DOE 1995g.

**TABLE 3.4.3.1–2.—*New Tritium Recycling Facility Operation Requirements***

| Requirement | Consumption |
|---|---|
| **Electrical Energy (MWh/yr)** | 88,000 |
| **Electrical Load (MWe)** | 16 |
| **Fuel** | |
| Gas ($ft^3$/yr) | 7,000,000 |
| Liquid (GPY) | 50,000 |
| **Water (MGY)** | |
| Wet site | 37 |
| Dry site | 14 |
| **Plant Footprint** | |
| Plant (acres) | 196 |
| **Employment** | |
| Total workers | 870 |
| Badged workers | 400 |

Source: DOE 1995g.

**TABLE 3.4.3.1–3.—*New Tritium Recycling Facility Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 117 |
| **Mixed Low-Level** | | |
| Liquid | None | 0.03 (6 gal) |
| Solid | None | 2 |
| **Hazardous** | | |
| Liquid | Included in solid | None |
| Solid | 0.5 | 1 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 4,460[a] (900,000 gal) | None[b] |
| Solid | 163[c] | 2,470 |
| **Nonhazardous (Other)** | | |
| Liquid | Included in sanitary | None |
| Solid | Included in sanitary | None |

[a] Does not include groundwater dewatering, if required.

[b] At a dry site, the treated effluent from blowdown plus sanitary, utility, and process wastewater treatment are recycled for reuse as cooling water makeup and other services after treatment. At the wet site, the effluent is 119,000 $yd^3$/yr (24,000,000 gal/yr).

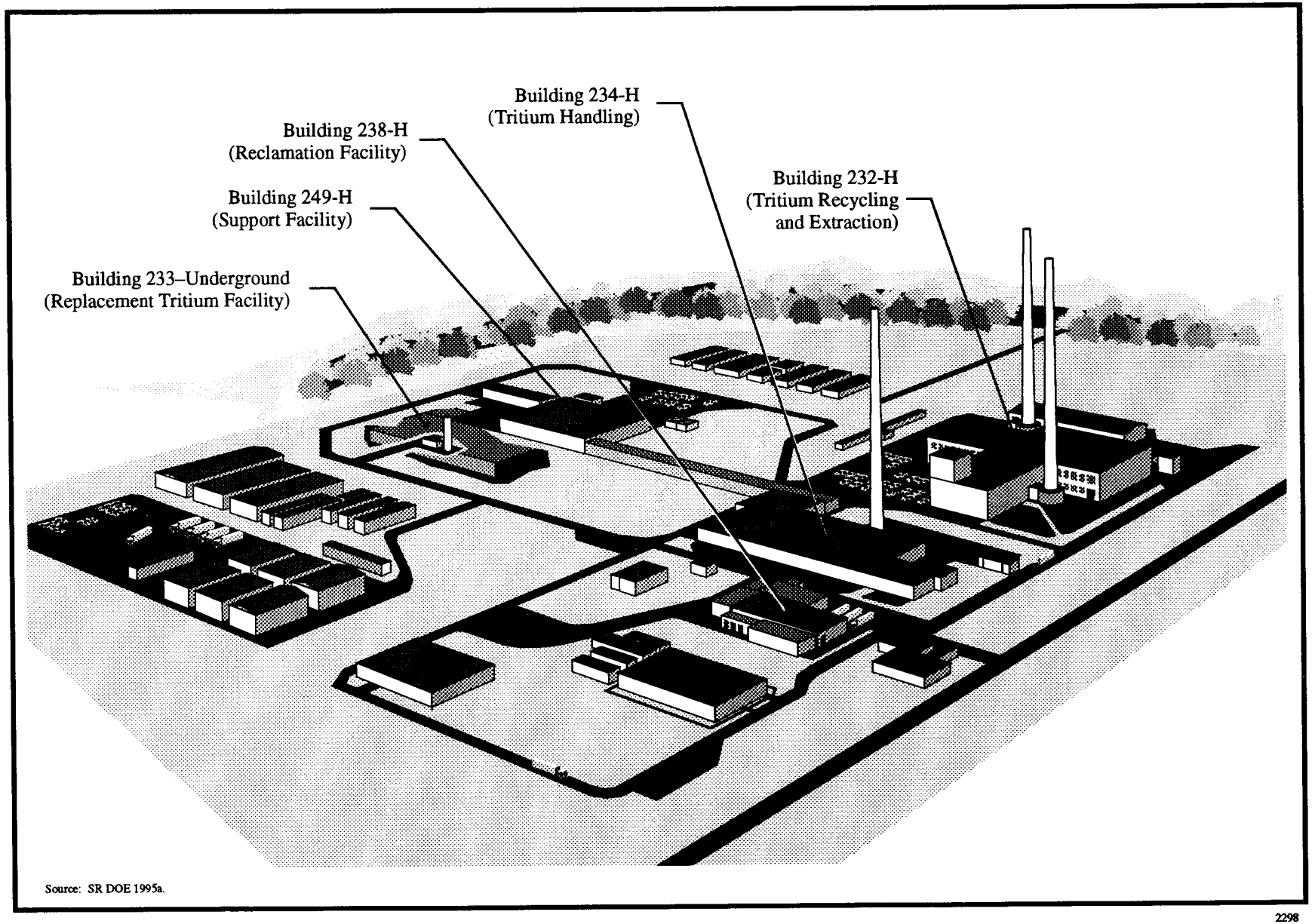
[c] Includes 20 tons of steel construction waste material which will be recycled as scrap metal.

Source: DOE 1995g.

### 3.4.3.2 *Tritium Recycling Facilities Upgrades at Savannah River Site*

If the tritium supply facilities are located at SRS or at one of the other sites without a collocated recycling facility, the existing tritium recycling facilities would be upgraded. The upgrade presented here, called the unconsolidated upgrade, would result in no buildings closed and no consolidation of tritium handling activities. Buildings 232-H, 232-1H, 234-H, 238-H, and 249-H (figure 3.4.3.2–1), would be upgraded to meet DOE Natural Phenomenon Hazards Requirements. These upgrades would involve the additions of wall and cross bracings to existing beams, strengthening some exterior walls, and reinforcing existing building frames. Additionally, Building 232-H would require an anchor for the service area roof slab as well as an upgrade to the Radiation Control and Monitoring System. Building 234-H would require upgrades to its reservoir storage encased safes which are used to protect filled reservoirs during high winds and earthquakes. No upgrade modifications would be required for buildings 233-H (Replacement Tritium Facility), 235-H, 236-H, and 720-H.

As a potential mitigation, a consolidation of tritium activities into fewer buildings to minimize tritium emissions and waste is also possible. In this upgrade, called the consolidated upgrade, Building 232-H would be closed and its functions transferred to buildings 233-H and 234-H. As discussed above, upgrades would then be made to buildings 232-1H, 234-H, 238-H, and 249-H. Additionally, Building 233-H would require modifications in order to accept activities transferred from Building 232-H. Construction and operation requirements for the recycling facilities upgrade at SRS are presented in tables 3.4.3.2–1 and 3.4.3.2–2. The estimated waste generation data is shown in tables 3.4.3.2–3 and 3.4.3.2–4.




Source: SR DOE 1995a.

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**FIGURE 3.4.3.2–1.—*Tritium Recycling Facilities Upgrades at Savannah River Site (Generalized).***

**TABLE 3.4.3.2–1.—*Upgraded Tritium Recycling Facilities Construction Requirements***

| Requirement | Consumption: Unconsolidated with Building 232-H | Consumption: Consolidated without Building 232-H |
|---|---|---|
| **Material/Resources** | | |
| Electrical energy (MWh) | 2,000 | 2,000 |
| Concrete ($yd^3$) | 1,900 | 2,100 |
| Steel (tons) | 210 | 240 |
| Gasoline, diesel fuel, and lube oil (gal) | 16,000 | 17,000 |
| Water (gal) | 130,000 | 140,000 |
| **Land Disturbance (acres)** | NA | NA |
| **Employment** | | |
| Total employment (worker years) | 62 | 91 |
| Peak employment (workers) | 26 | 36 |
| Construction period (years) | 3 | 3 |

Source: SR DOE 1995a.

**TABLE 3.4.3.2–2.—*Upgraded Tritium Recycling Facilities Operation Requirements***

| Requirement | Consumption: Unconsolidated with Building 232-H[a] | Consumption: Consolidated without Building 232-H |
|---|---|---|
| **Electrical Energy (MWh/yr)** | 24,000 | 24,000 |
| **Electrical Load (MWe)** | 3 | 3 |
| **Coal (tons)** | 5,200 | 5,200 |
| **Fuel, Liquid (GPY)** | 60,000 | 56,000 |
| **Water (MGY)** | 51 | 51 |
| **Employment** | | |
| Total workers | 970 | 910 |
| Badged workers | 400 | 400 |

[a] These figures are included in No Action and represent phase out data.

Source: SR DOE 1995a.

**TABLE 3.4.3.2–3.—*Upgraded Tritium Recycling Facilities (Unconsolidated–With Building 232-H) Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 117 |
| **Mixed Low-Level** | | |
| Liquid | None | 0.03 (6 gal) |
| Solid | None | 2 |
| **Hazardous** | | |
| Liquid | Included in solid | None |
| Solid | <0.3 | 1 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 149[a] (30,000 gal) | 158,000 (32,000,000 gal) |
| Solid | 14[b] | 2,600 |
| **Nonhazardous (Other)** | | |
| Liquid | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Does not include groundwater dewatering, if required.
[b] Includes 1 ton of steel construction waste material which would be recycled as scrap metal.
Source: SR DOE 1995a.

**TABLE 3.4.3.2–4.—*Upgraded Tritium Recycling Facilities (Consolidated–Without Building 232-H) Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 117 |
| **Mixed Low-Level** | | |
| Liquid | None | 0.03 (6 gal) |
| Solid | None | 2 |
| **Hazardous** | | |
| Liquid | Included in solid | None |
| Solid | <0.3 | 1 |
| **Nonhazardous (Sanitary)** | | |
| Liquid | 182[a] (36,700 gal) | 153,000 (31,000,000 gal) |
| Solid | 15[b] | 2,470 |
| **Nonhazardous (Other)** | | |
| Liquid | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None |

[a] Does not include groundwater dewatering, if required.
[b] Includes 1.3 tons of steel construction waste material which would be recycled as scrap metal.
Source: SR DOE 1995a.

## 3.5 POLLUTION PREVENTION

The *Pollution Prevention Act* of 1990 established a national policy that whenever feasible, pollution should be prevented or reduced at the source. Under the Act, pollution that cannot be prevented should be recycled in an environmentally safe manner. Disposal or other releases into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner. Executive Order 12856, dated August 3, 1993, and DOE Order 5400.1 implement the provisions of the *Pollution Prevention Act* of 1990.

Pollution prevention is designed to keep pollutants from being released to the environment. These preventive measures include source reduction, recycling, treatment, and disposal. The emphasis is on source reduction and recycling to prevent the creation of wastes, i.e., waste minimization. Source reduction and waste minimization techniques include good operating practices, technology modifications, input material changes, and product changes. Use and reuse plus reclamation are onsite and offsite recycling techniques.Tritium supply and recycling facility designs would consider and incorporate waste minimization and pollution prevention to the maximum extent practicable. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Some designs produce waste quantities or waste forms that could undergo additional reductions by utilizing emerging technologies. Pollution prevention and waste minimization would be major factors in determining the final design of any facility constructed as part of the Complex. Pollution prevention and waste minimization would also be analyzed as part of the site-specific analyses and tiered NEPA documents following the decision on tritium supply and recycling facilities.

## 3.6 COMPARISON OF TRITIUM SUPPLY AND RECYCLING ALTERNATIVES

A comparison of the environmental impacts of the tritium supply and recycling alternatives is summarized in table 3.6–1 at the end of the chapter. This table compares the impacts to each environmental resource associated with tritium supply technologies and recycling at each of the five candidate sites. In addition, impacts associated with No Action are included for a baseline comparison.

The table 3.6–1 format presents the impacts of each alternative by resource or issue. Impacts associated with collocation of a tritium supply and recycling alternatives are evaluated for every site except SRS. At SRS, impacts are evaluated for a tritium supply with upgraded recycling. In addition, impacts associated with tritium supply alone alternatives are evaluated for all the candidate sites except SRS. A supply alone alternative does not exist for SRS because of existing recycling facilities. The tritium upgrade at SRS is part of the supply alone alternatives at the other four candidate sites (INEL, NTS, ORR, and Pantex). For the supply alone alternatives, there would be minor impacts associated with upgrading the facilities at SRS.

Under No Action (2010), DOE would not establish a new tritium supply capability, the current inventory of tritium would decay and DOE would not meet stockpile requirements of tritium. Sites would continue waste management programs to meet the legal requirements and commitments in formal agreements and would proceed with cleanup activities. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for the year 2010 and beyond. The current DOE missions assumed to continue under No Action are listed in section 3.3 for each candidate site.

## 3.7 PREFERRED ALTERNATIVE

CEQ regulations require that an agency identify its preferred alternative, if one or more exists, in the Draft Environmental Impact Statement (EIS) (40 CFR 1502.14(e)). The preferred alternative is the

alternative that the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. Consequently, to identify a preferred alternative, the Department has developed information on potential environmental impacts, and is continuing to develop costs, technical risks, and schedule risks for the alternatives under consideration. For this draft PEIS, no preferred alternatives exist for (1) tritium supply technology; (2) tritium supply site; or (3) tritium recycling site.

The final PEIS will include any preferred alternatives. However, the Department may choose to identify a preferred alternative prior to publication of the final PEIS. The ROD will describe the Department's decision for tritium supply and recycling.

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 1 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Land Resources—No Action** | | | | |
| • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. |
| **Land Resources** | | | | |
| • Construction and operation of a tritium supply would disturb between 173 acres and 360 acres. The disturbance for each technology would be:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres | • Construction and operation of a tritium supply would disturb between 173 acres and 360 acres. The disturbance for each technology would be:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres | • Construction and operation of a tritium supply would disturb between 173 acres and 360 acres. The disturbance for each technology would be:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres | • Construction and operation of a tritium supply would disturb between 173 acres and 360 acres. The disturbance for each technology would be:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres | • Construction and operation of a tritium supply and upgraded recycling would disturb between 173 acres and 360 acres. The disturbance for each technology would be:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres |
| • Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation for all technologies. | • Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation for all technologies. | • Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation for all technologies. | • Collocation of tritium recycling would require an additional 202 acres during construction and 196 acres during operation for all technologies. | • No additional land needed for upgraded recycling facilities. |
| • The existing VRM classification of Class 4 visual landscape characteristics would remain unchanged. | • The existing VRM classification of the proposed site would change from Class 2 to Class 4. Depending on the final siting, the facilities may be visible from a portion of the Desert National Wildlife Range. | • The existing VRM classification of Class 4 visual landscape characteristics would change to Class 5, and the use of an evaporative cooling system would result in visible plumes during certain atmospheric conditions. | • The existing VRM classification of Class 4 visual landscape characteristics would remain unchanged. | • The existing VRM classification of Class 4 visual landscape characteristics would change to Class 5, and the use of a wet cooling system would result in visible plumes during certain atmospheric conditions. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 2 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Site Infrastructure—No Action** | | | | |
| • Under No Action the peak electrical load requirement would reduce by 51 MWe. Annual energy consumption would remain the same. | • Under No Action the peak electrical load requirement would reduce by 7 MWe. Annual energy consumption would remain the same. | • Under No Action the peak electrical load requirement would reduce by 1,304 MWe. Annual energy consumption would reduce by 11,641,800 MWh per year. | • Under No Action the peak electrical load requirement would reduce by 1 MWe. Annual energy consumption would reduce by 7,000 MWh per year. | • Under No Action the peak electrical load requirement would reduce by 214 MWe. Annual energy consumption would reduce by 878,000 MWh per year. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • Collocated tritium supply and recycling would increase the current site electrical requirement by 11 MWe to 515 MWe. The increase for each technology would be:<br><br>HWR: 34 MWe<br>MHGTR: 11 MWe<br>Large ALWR: 105 MWe<br>Small ALWR: 40 MWe<br>Full APT: 515 MWe<br>Phased APT: 320 MWe | • Collocated tritium supply and recycling would increase the current site electrical requirement by 55 MWe to 559 MWe. The increase for each technology would be:<br><br>HWR: 78 MWe<br>MHGTR: 55 MWe<br>Large ALWR: 149 MWe<br>Small ALWR: 84 MWe<br>Full APT: 559 MWe<br>Phased APT: 364 MWe | • Collocated tritium supply and recycling would require less than the current site electrical requirement by 738 MWe to 1,252 MWe. The reduction for each technology would be:<br><br>HWR: 1,237 MWe<br>MHGTR: 1,252 MWe<br>Large ALWR: 1,192 MWe<br>Small ALWR: 1,236 MWe<br>Full APT: 738 MWe<br>Phased APT: 933 MWe | • Collocated tritium supply and recycling would increase the current site electrical requirement by 61 MWe to 565 MWe. The increase in additional current capacity for each technology would be:<br><br>HWR: 84 MWe<br>MHGTR: 61 MWe<br>Large ALWR: 155 MWe<br>Small ALWR: 90 MWe<br>Full APT: 565 MWe<br>Phased APT: 370 MWe | • Tritium supply and upgraded recycling would range from less than the current site electrical requirement by 163 MWe to an increase in the current capacity by 336 MWe. The change in current capacity for each technology would be:<br>HWR: 163 MWe (less)<br>MHTGR: 178 MWe (less)<br>Large ALWR: 118 MWe (less)<br>Small ALWR: 162 MWe (less)<br>Full APT: 336 MWe (increase)<br>Phased APT: 141 MWe (increase) |
| • The percent of the power pool capacity margin ranges from 0.45 to 4.15<br>HWR: 0.62<br>MHTGR: 0.45<br>Large ALWR: 1.14<br>Small ALWR: 0.67<br>Full APT: 4.15<br>Phased APT: 2.72 | • The percent of the power pool capacity margin ranges from 0.53 to 4.79.<br>HWR: 0.72<br>MHTGR: 0.53<br>Large ALWR: 1.32<br>Small ALWR: 0.77<br>Full APT: 4.79<br>Phased APT: 3.14 | • The percent of the power pool capacity margin ranges from 1.14 to 12.44.<br>HWR: 1.47<br>MHTGR: 1.14<br>Large ALWR: 2.46<br>Small ALWR: 1.50<br>Full APT: 12.44<br>Phased APT: 8.15 | • The percent of the power pool capacity margin ranges from 0.47 to 4.28.<br>HWR: 0.64<br>MHTGR: 0.47<br>Large ALWR: 1.18<br>Small ALWR: 0.69<br>Full APT: 4.28<br>Phased APT: 2.80 | • The percent of the power pool capacity margin ranges from 0.35 to 5.27.<br>HWR: 0.49<br>MHTGR: 0.35<br>Large ALWR: 0.92<br>Small ALWR: 0.50<br>Full APT: 5.27<br>Phased APT: 3.40 |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 3 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • No supply alone. |
| **Air Quality and Acoustics—No Action** | | | | |
| • Under No Action no change from existing conditions. | • Under No Action no change from existing conditions. | • Under No Action no change from existing conditions. | • Under No Action no change from existing conditions. | • Under No Action no change from existing conditions. |
| | | **Collocated Tritium Supply and Recycling** | | |
| • Construction of collocated tritium supply and recycling facilities would result in exceedance of 24-hour $PM_{10}$ and TSP standards. Air pollutant concentration would increase during operation but would be within standards. Noise levels would increase during construction and operation. | • Construction of collocated tritium supply and recycling facilities would result in exceedance of 24-hour $PM_{10}$ and TSP standards. Air pollutant concentration would increase during operation but would be within standards. Noise levels would increase during construction and operation. | • Construction of collocated tritium supply and recycling facilities would result in exceedance of 24-hour $PM_{10}$ and TSP standards. Air pollutant concentration would increase during operation but would be within standards. Noise levels would increase during construction and operation. | • Construction of collocated tritium supply and recycling facilities would result in exceedance of 24-hour $PM_{10}$ standard. Air pollutant concentration would increase during operation but would be within standards. Noise levels would increase during construction and operation. | • Construction of collocated tritium supply and upgraded recycling facilities would result in exceedance of 24-hour $PM_{10}$ standards. Air pollutant concentration would increase during operation but would be within standards. Noise levels would increase during construction and operation. |
| | | **Tritium Supply Alone** | | |
| • Construction and operation air and noise emissions for the tritium supply alone would be slightly less than those expected above. | • Construction and operation air and noise emissions for the tritium supply alone would be slightly less than those expected above. | • Construction and operation air and noise emissions for the tritium supply alone would be slightly less than those expected above. | • Construction and operation air and noise emissions for the tritium supply alone would be slightly less than those expected above. | • No supply alone. |
| **Water Resources—No Action** | | | | |
| • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 4 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • Surface water would not be used during construction. | • Surface water would not be used during construction. | • Surface water use for collocated supply and recycling facilities would range from 10 MGY to 35 MGY during construction. The surface water use and corresponding percentage increase by technology would be:<br>HWR: 23 (1 percent)<br>MHTGR: 19 (1 percent)<br>Large ALWR: 35 (2 percent)<br>Small ALWR: 22 (1 percent)<br>APT: 10 (<1 percent) | • Surface water would not be used during construction. | • Surface water would not be used during construction. |
| • Groundwater use would range from 10 MGY to 35 MGY during construction. The groundwater use by technology would be:<br>HWR: 23<br>MHTGR: 19<br>Large ALWR: 35<br>Small ALWR: 22<br>APT : 10 | • Groundwater use would range from 10 MGY to 35 MGY during construction. The groundwater use by technology would be:<br>HWR: 23<br>MHTGR: 19<br>Large ALWR: 35<br>Small ALWR: 22<br>APT: 10 | • Groundwater would not be used during construction or operation of any collocated tritium supply and recycling. | • Groundwater use would range from 10 MGY to 35 MGY during construction. The groundwater use by technology would be:<br>HWR: 23<br>MHTGR: 19<br>Large ALWR: 35<br>Small ALWR: 22<br>APT : 10 | • Groundwater use would range from 8 MGY to 33 MGY during construction. The groundwater use by technology would be:<br>HWR: 21<br>Large ALWR: 33<br>Small ALWR: 20<br>MHTGR: 18<br>APT: 8 |
| • The total percent of groundwater use increase during construction by technology would be:<br>HWR: 1<br>MHTGR: 1<br>Large ALWR: 2<br>Small ALWR: 1<br>Full APT: <1<br>Phased APT: <1 | • The total percent of groundwater use increase during construction by technology would be:<br>HWR: 4<br>MHTGR: 3<br>Large ALWR: 6<br>Small ALWR: 3<br>Full APT: 2<br>Phased APT: 2 | • No groundwater use. | • The total percent of groundwater use increase during construction by technology would be:<br>HWR: 8<br>MHTGR: 7<br>Large ALWR: 2<br>Small ALWR: 1<br>Full APT: 3<br>Phased APT: 3 | • The total percent of groundwater use increase during construction by technology would be:<br>HWR: 1<br>MHTGR: 1<br>Large ALWR: 1<br>Small ALWR: 1<br>Full APT: <1<br>Phased APT: <1 |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 5 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • No construction will take place in 100- or 500-year floodplains. | • No construction will take place in areas designated as 100-year floodplains, however a 500-year flood plain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however a 500-year flood plain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however a 500-year flood plain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however a 500-year flood plain assessment would be required. |
| • Stormwater runoff would have negligible impacts on surface water during construction and operation. | • Stormwater runoff would have negligible impacts on surface water during construction and operation. | • Stormwater runoff would have negligible impacts on surface water during construction and operation. | • Stormwater runoff would have negligible impacts on surface water during construction and operation. | • Stormwater runoff would have negligible impacts on surface water during construction and operation. |
| • Surface water would not be used during operation. | • Surface water would not be used during operation. | • Operation surface water requirements would range from 2,656 to 16,014 MGY. The surface water use and corresponding percentage increase by technology would be:<br>HWR: 5,914 (320 percent)<br>MHTGR: 4,044 (219 percent)<br>Large ALWR: 16,014 (866 percent)<br>Small ALWR: 7,214 (390 percent)<br>Full APT: 2,656 (144 percent)<br>Phased APT: 1,705 (92 percent) | • Surface water would not be used during operation. | • Operation surface water requirements would range from 2,665 MGY to 15,530 MGY. The surface water use and corresponding percentage increase by technology would be:<br>HWR: 5,830 (29 percent)<br>MHTGR: 4,030 (20 percent)<br>Large ALWR: 15,530 (78 percent)<br>Small ALWR: 7,130 (36 percent)<br>Full APT: 2,665 (13 percent)<br>Phased APT: 1,714 (9 percent) |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 6 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • No blowdown discharges to surface water. | • No blowdown discharges to surface water. | • Blowdown discharges to surface waters would range from 528 MGY to 6,192 MGY. Blowdown discharges to surface waters by technology would be:<br>HWR: 2,304<br>MHTGR: 1,608<br>Large ALWR: 6,192<br>Small ALR: 2,808<br>Full APT: 528<br>Phased APT: 288 | • No blowdown discharges to surface water. | • Blowdown discharges to surface waters would range from 528 MGY to 6,192 MGY. Blowdown discharges to surface waters by technology would be:<br>HWR: 2,304<br>MHTGR: 1,608<br>Large ALWR: 6,192<br>Small ALWR: 2,808<br>Full APT: 528<br>Phased APT: 288 |
| • Groundwater requirements for operation would range from 44 MGY to 2,656 MGY. The groundwater use by technology would be:<br>HWR: 62<br>MHTGR: 44<br>Large ALWR: 104<br>Small ALWR: 64<br>Full APT: 2,656<br>Phased APT: 1,705 | • Groundwater requirements for operation would range from 44 MGY to 2,656 MGY. The groundwater use by technology would be:<br>HWR: 62<br>MHTGR: 44<br>Large ALWR: 104<br>Small ALWR: 64<br>APT: 2,656<br>Phased APT: 1,705 | • Groundwater would not be used for operation. | • Groundwater requirements for operation would range from 44 MGY to 2,656 MGY. The groundwater use by technology would be:<br>HWR: 62<br>MHTGR: 44<br>Large ALWR: 104<br>Small ALWR: 64<br>APT: 2,656<br>Phased APT: 1,705 | • Groundwater requirements for operation would range from 28 MGY to 111 MGY. The groundwater use by technology would be:<br>HWR: 69<br>MHTGR: 51<br>Large ALWR: 111<br>Small ALWR: 71<br>Full APT: 28<br>Phased APT: 28 |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 7 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The total percent of groundwater use during operation by technology would be:<br>HWR: 3<br>MHTGR: 2<br>Large ALWR: 5<br>Small ALWR: 3<br>Full APT: 132<br>Phased APT: 85<br>Total groundwater use for all the technologies except APT would be approximately 18 percent of the INEL groundwater allotment; the APT groundwater use represents approximately 41 percent of the INEL groundwater allotment. | • The total percent of groundwater use during operation by technology would be:<br>HWR: 8<br>MHTGR: 5<br>Large ALWR: 14<br>Small ALWR: 8<br>Full APT: 417<br>Phased APT: 267<br>Groundwater withdrawals during operation would not exceed the lowest estimates aquifer recharge rate for all technologies except for the APT. For the APT, withdrawals during operation of the Full APT exceed the lowest estimated recharge rate by 19 percent, but would not be expected to impact offsite springs. | • No groundwater use. | • The total percent of groundwater use during operation by technology would be:<br>HWR: 17<br>MHTGR: 10<br>Large ALWR: 31<br>Small ALWR: 17<br>Full APT: 924<br>Phased APT: 591<br>Drawdowns during operation could affect aquifer water levels. | • The total percent of groundwater use during operation by technology would be:<br>HWR: 2<br>MHTGR: 2<br>Large ALWR: 3<br>Small ALWR: 3<br>Full APT: 2<br>Phased APT: 2 |
| **Tritium Supply Alone** | | | | |
| • The groundwater requirement for the tritium supply alone would be 1.5 MGY less than for collocation during construction and 14 MGY less than for collocation during operation for all technologies. No surface water would be used. | • The groundwater requirement for the tritium supply alone would be 1.5 MGY less than for collocation during construction and 14 MGY less than for collocation during operation for all technologies. No surface water would be used. | • No groundwater would be used. Total surface water requirement for the tritium supply alone would be 1.5 MGY less than for collation during construction and 14 MGY less than for collocation during operation for all technologies. | • The groundwater requirement for the tritium supply alone would be 1.5 MGY less than for collocation during construction and 14 MGY less than for collocation during operation for all technologies. No surface water would be used. | • No tritium supply alone. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 8 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Geology and Soils—No Action** | | | | |
| • Under No Action there would be no impacts to geology or soils. | • Under No Action there would be no impacts to geology or soils. | • Under No Action there would be no impacts to geology or soils. | • Under No Action there would be no impacts to geology or soils. | • Under No Action there would be no impacts to geology or soils. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • Construction and operation for collocated supply and recycling or the tritium supply alone would neither affect nor be affected by geological conditions. | • Construction and operation for collocated supply and recycling or the tritium supply alone would neither affect nor be affected by geological conditions. | • Construction and operation for collocated supply and recycling or the tritium supply alone would neither affect nor be affected by geological conditions. | • Construction and operation for collocated supply and recycling or the tritium supply alone would neither affect nor be affected by geological conditions. | • Construction and operation of tritium supply with upgraded recycling would neither affect nor be affected by geological conditions. |
| • The soil disturbed area for collocated supply and recycling would range from 375 acres to 562 acres. The acres disturbed by each technology would be:<br>HWR: 462<br>MHTGR: 562<br>ALWR: 552<br>APT: 375 | • The soil disturbed area for collocated supply and recycling would range from 375 acres to 562 acres. The acres disturbed by each technology would be:<br>HWR: 462<br>MHTGR: 562<br>ALWR: 552<br>APT: 375 | • The soil disturbed area for collocated supply and recycling would range from 375 acres to 562 acres. The acres disturbed by each technology would be:<br>HWR: 462<br>MHTGR: 562<br>ALWR: 552<br>APT: 375 | • The soil disturbed area for collocated supply and recycling would range from 375 acres to 562 acres. The acres disturbed by each technology would be:<br>HWR: 462<br>MHTGR: 562<br>ALWR: 552<br>APT: 375 | • The soil disturbed area for tritium supply with upgraded recycling would range from 173 acres to 360 acres. The acres disturbed by each technology would be:<br>HWR: 260<br>MHTGR: 360<br>ALWR: 350<br>APT: 173 |
| **Tritium Supply Alone** | | | | |
| • The disturbed area for the tritium supply alone would be 202 acres less. | • The disturbed area for the tritium supply alone would be 202 acres less. | • The disturbed area for the tritium supply alone would be 202 acres less. | • The disturbed area for the tritium supply alone would be 202 acres less. | • No tritium supply alone. |
| • Soil erosion due to wind and stormwater runoff would be minor. | • Soil erosion due to wind and stormwater runoff would be minor. | • Soil erosion due to wind and stormwater runoff would be minor. | • Soil erosion due to wind and stormwater runoff would be minor. | • Soil erosion due to wind and stormwater runoff would be minor. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 9 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Biotic Resources—No Action** | | | | |
| • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • Construction and operation of a collocated tritium supply and recycling or supply alone, would affect terrestrial resources. The impact would vary by the acreage disturbed during construction for each technology (see geology and soils for acreage). | • Construction and operation of a collocated tritium supply and recycling or supply alone, would affect terrestrial resources. The impact would vary by the acreage disturbed during construction for each technology (see geology and soils for acreage). | • Construction and operation of a collocated tritium supply and recycling, or supply alone, would affect terrestrial resources. The impact would vary by the acreage disturbed during construction for each technology (see geology and soils for acreage). | • Construction and operation of a collocated tritium supply and recycling, or supply alone, would affect terrestrial resources. The impact would vary by the acreage disturbed during construction for each technology (see geology and soils for acreage). | • Construction and operation of a tritium supply with upgraded recycling, would affect terrestrial resources. The impact would vary by the acreage disturbed during construction for each technology (see geology and soils for acreage). |
| • Impacts from cooling system salt drift are possible with APT. | • Impacts from cooling system salt drift are possible with APT. | • Salt drift from wet cooling towers would likely impact less than 13 acres during operation for all technologies. | • Impacts from cooling system salt drift are possible with APT. | • Salt drift from wet cooling towers would likely impact less than 13 acres during operation for all technologies. |
| • Wetlands and aquatic resources would not be affected. | • Wetlands and aquatic resources would not be affected. | • Without appropriate mitigation measures, increased stream flow from operational discharges could affect wetland and aquatic plant communities. | • Without appropriate mitigation measures, playa wetlands could be degraded by discharges, aquatic resources would not be affected. | • Without appropriate mitigation measures, construction and operational discharges to an onsite stream could affect wetland and aquatic communities. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 10 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidates or state-listed species may be affected. | • One Federal-listed, threatened, the desert tortoise, could be affected during construction and operation. Several Federal candidate or state-listed species may be affected. | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidates or state-listed species may be affected. | • One Federal-listed, threatened species, the bald eagle, and six Federal candidate or state-listed species may be affected by construction activities. | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidates or state-listed species may be affected. |
| • The ferruginous hawk would lose foraging habitat equal to the amount of land disturbed for each technology during construction and operation. The Townsend's western big-eared bat may roost and forage throughout the disturbed area during construction and forage at stormwater retention ponds during operation. | • The ferruginous hawk could lose foraging habitat equal to the amount of land disturbed for each technology during construction and operation. The loggerhead shrike could lose foraging and breeding habitats well. Neither species should be adversely affected due to the large extent of nearby suitable habitat. | • Four state-listed raptors would lose potential nesting and foraging habitat equal to the amount of disturbed land for each technology, however this type of habitat is abundant in the area. The Tennessee dace and hellbender, both state-listed, could be affected by construction. | • The black tern, white-faced ibis, ferruginous hawk, loggerhead shrike, and bald eagle could lose foraging and/or nesting habitat equal to the amount of land disturbed for each technology during construction. The swift fox would lose potential foraging and denning habitat. The Texas horned lizard could be impacted during land clearing activities. | • The potentially affected species include the awned meadow-beauty, green-fringed orchid, Florida false loosestrife, beakrush, star-nosed mole and the eastern tiger salamander would lose foraging habitat equal to the disturbed land during construction for each technology. |
| **Cultural and Paleontological Resources—No Action** | | | | |
| • Under No Action there would be no impact to cultural and paleontological resources. | • Under No Action there would be no impact to cultural and paleontological resources. | • Under No Action there would be no impact to cultural and paleontological resources. | • Under No Action there would be no impact to cultural and paleontological resources. | • Under No Action there would be no impact to cultural and paleontological resources. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • Some NRHP-eligible prehistoric and historic resources may occur within the tritium supply site. | • Some NRHP-eligible prehistoric and historic resources may occur within the tritium supply site. | • Some NRHP-eligible prehistoric and historic resources may occur within the tritium supply site. | • Some NRHP-eligible prehistoric and historic resources may occur within the tritium supply site. | • Three NRHP-eligible historic sites occur within the area proposed for construction and operation of a tritium supply. No prehistoric resources would be affected. |
| • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 11 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • Paleontological resources may be affected when excavation exceeds 50 feet. | • Paleontological resources may be affected. | • Paleontological resources may be affected. | • Paleontological resources may be affected. | • Paleontological resources may be affected. |
| | | **Tritium Supply Alone** | | |
| • Impacts to cultural and paleontological resources from a tritium supply alone would be less. | • Impacts to cultural and paleontological resources from a tritium supply alone would be less. | • Impacts to cultural and paleontological resources from a tritium supply alone would be less. | • Impacts to cultural and paleontological resources from a tritium supply alone would be less. | • No tritium supply alone. |
| | | **Socioeconomics—No Action** | | |
| • Under No Action INEL employment decreased by 1,000 persons between 1990 and 1994 to 10,100 persons, and will remain at this level through the year 2020. | • Under No Action NTS employment decreased by 1,170 persons between 1990 and 1994 to 6,850 persons and will remain at this level through the year 2020. | • Under No Action ORR employment decreased by 300 persons between 1990 and 1994 to 15,000 persons, and will remain at this level through the year 2020. | • Under No Action Pantex employment increased by 1,000 persons between 1990 and 1994 to 3,400 persons. It will decrease to 1,790 in 2010 and is expected to remain at this level through 2020. | • Under No Action SRS employment decreased by 2,000 persons between 1990 and 1994 to 20,300 persons. It will decrease to 16,900 by 2010 and is expected to remain at this level through the year 2020. |
| • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually through the year 2010, and then decrease by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually through the year 2009, and then continue to increase by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by 1 percent annually through the year 2009, and then grow by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually between 2001 and 2020. |
| • Under No Action unemployment is expected to be at 6.4 percent between the years 2001 and 2020. Per capita income is expected to increase from $17,800 to $20,900. | • Under No Action unemployment is expected to be at 5 percent between the years 1999 and 2020. Per capita income is expected to increase from $23,600 to $25,100. | • Under No Action unemployment is expected to be at 6.2 percent between the years 2001 and 2020. Per capita income is expected to increase from $17,900 to $20,700. | • Under No Action unemployment is expected to be at 4.6 percent between the years 2001 and 2020. Per capita income is expected to increase from $22,300 to $25,700. | • Under No Action unemployment is expected to be at 4.8 percent between the years 2001 and 2020. Per capita income is expected to increase from $18,300 to $21,000. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 12 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **No Action** | | |
| • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2010. | • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2020. | • Under No Action population and housing annual average increase is expected to be 1 percent through the year 2009 and less than 1 percent between 2010 and 2020. | • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2020. | • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2010. |
| • Population is expected to reach 207,300 in 2010 and 215,200 in 2020. | • Population is expected to reach 1,020,900 in 2010 and 1,103,500 in 2020. | • Population is expected to reach 561,000 in 2010 and 586,000 in 2020. | • Population is expected to reach 205,100 in 2010 and 209,000 in 2020. | • Population is expected to reach 454,900 in 2010 and 473,000 in 2020. |
| • Under No Action total revenue and expenditures for the region-of-influence counties, cities and school districts is expected to increase by an annual average of less than 1 percent from 2001 to 2020. | • Under No Action total revenue and expenditures for the region-of-influence counties, cities and school districts is expected to increase by an annual average of less than 1 percent to 4 percent between 2001 and 2005, and by 1 to 2 percent between 2005 and 2010. Between 2010 and 2020, annual increases of less than 1 percent are expected. | • Under No Action total revenue and expenditures for the region-of-influence counties, cities and school districts is expected to increase by an annual average of approximately 1 percent or less through 2010 to 2020. | • Under No Action total revenue and expenditures for the region-of-influence counties, cities and school districts is expected to increase by an annual average of less than 1 percent through 2020. | • Under No Action total revenue and expenditures for the region-of-influence counties, cities and school districts is expected to increase by an annual average of less than 1 percent through 2020. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 13 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • Employment in the economic study area would increase by 4,800 to 10,800 persons during peak construction when collocating tritium supply and recycling. The increase by technology would be:<br>HWR: 7,500<br>MHTGR: 7,200<br>ALWR: 10,800<br>APT: 4,800 | • Employment in the economic study area would increase by between 6,000 to 13,700 persons during peak construction when collocating tritium supply and recycling. The increase by technology would be:<br>HWR: 9,500<br>MHTGR: 7,900<br>ALWR: 13,700<br>APT: 6,000 | • Employment in the economic study area would increase by 5,300 to 12,000 persons during peak construction when collocating tritium supply and recycling. The increase by technology would be:<br>HWR: 8,000<br>MHTGR: 9,000<br>ALWR: 12,000<br>APT: 5,300 | • Employment in the economic study area would increase by 4,800 to 11,000 persons during peak construction when collocating tritium supply and recycling. The increase by technology would be:<br>HWR: 7,600<br>MHTGR: 7,300<br>ALWR: 11,000<br>APT: 4,800 | • Employment in the economic study area would increase by 4,200 to 11,700 persons during peak construction of tritium supply and upgraded recycling. The increase by technology would be:<br>HWR: 7,200<br>MHTGR: 6,900<br>ALWR: 11,700<br>APT: 4,200 |
| • Unemployment in the economic study area would decrease from 6.4 percent (the projected baseline) to 4.5 percent for all technologies during peak construction. | • Unemployment in the economic study area would decrease from 5.0 percent (the projected baseline) to 3.9 percent for all technologies during peak construction except the APT, which would decrease to 4.0 percent. | • Unemployment in the economic study area would decrease from 6.2 percent (the projected baseline) to 5.5 percent to 4.8 percent during peak construction. The estimated unemployment by technology would be:<br>HWR: 5.2 percent<br>MHTGR: 5.2 percent<br>ALWR: 4.8 percent<br>APT: 5.5 percent | • Unemployment in the economic study area would decrease from 4.6 percent (the projected baseline) to 2.7 percent to 2.2 percent during peak construction. The estimated unemployment by technology would be:<br>HWR: 2.2 percent<br>MHTGR: 2.2 percent<br>ALWR: 2.2 percent<br>APT: 2.7 percent | • Unemployment in the economic study area would decrease from 4.8 percent (the projected baseline) to 4.2 percent to 3.9 percent during peak construction. The estimated unemployment by technology would be:<br>HWR: 3.9 percent<br>MHTGR: 4.0 percent<br>ALWR: 3.9 percent<br>APT: 4.2 percent |
| • Population and housing demand within the region of influence would increase by 2 percent to 9 percent during construction of a collocated tritium supply and recycling facility. The increase by technology would be:<br><br>HWR: 5 percent<br>MHTGR: 5 percent<br>ALWR: 9 percent<br>APT: 2 percent | • Population and housing demand within the region of influence would not increase by more than 1 percent over No Action during construction all technologies except for the ALWR, which would increase by 2 percent. | • Population and housing demand within the region of influence would not increase by more than 1 percent during construction for all technologies, except ALWR where it will not increase by more than 2 percent during construction. | • Population and housing demand within the region of influence would increase by 2 percent to 7 percent during construction of a collocated tritium supply and recycling facility. The increase by technology would be:<br><br>HWR: 4 percent<br>MHTGR: 3 percent<br>ALWR: 7 percent<br>APT: 2 percent | • Population and housing demand within the region of influence would increase by 1 percent to 3 percent during construction of a tritium supply and upgraded recycling facility. The increase by technology would be:<br><br>HWR: 1 percent<br>MHTGR: 1 percent<br>ALWR: 3 percent<br>APT: 1 percent |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 14 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • Employment in the economic study area would increase by 4,100 to 4,900 persons during full operation. The increase by technology would be:<br>HWR: 4,900<br>MHTGR: 4,900<br>ALWR: 4,700<br>APT: 4,100 | • Employment in the economic study area would increase by 4,600 to 5,500 persons during full operation. The increase by technology would be:<br>HWR: 5,500<br>MHTGR: 5,500<br>ALWR: 5,200<br>APT: 4,600 | • Employment in the economic study area would increase by 4,300 to 5,200 persons during full operation. The increase by technology would be:<br>HWR: 5,200<br>MHTGR: 5,100<br>ALWR: 4,900<br>APT: 4,300 | • Employment in the economic study area would increase by 4,400 to 6,000 persons during full operation. The increase by technology would be:<br>HWR: 5,500<br>MHTGR: 6,000<br>ALWR: 5,000<br>APT: 4,400 | • Employment in the economic study area would increase by 1,600 to 2,400 persons during full operation. The increase by technology would be:<br>HWR: 2,400<br>MHTGR: 2,300<br>ALWR: 2,100<br>APT: 1,600 |
| • Unemployment in the economic study area would decrease from 6.4 percent (the projected baseline) to 4.9 percent to 4.6 percent during full operation. The estimated unemployment by technology would be:<br>HWR: 4.6 percent<br>MHTGR: 4.6 percent<br>ALWR: 4.7 percent<br>APT: 4.9 percent | • Unemployment in the economic study area would decrease from 5.0 percent (the projected baseline) to 4.6 percent to 4.3 percent during full operation. The estimated unemployment by technology would be:<br>HWR: 4.3 percent<br>MHTGR: 4.6 percent<br>ALWR: 4.4 percent<br>APT: 4.4 percent | • Unemployment in the economic study area would decrease from 6.2 percent (the projected baseline) to 5.7 percent to 5.6 percent during full operation. The estimated unemployment by technology would be:<br>HWR: 5.6 percent<br>MHTGR: 5.6 percent<br>ALWR: 5.6 percent<br>APT: 5.7 percent | • Unemployment in the economic study area would decrease from 4.6 percent (the projected baseline) to 2.8 percent to 2.4 percent during full operation. The estimated unemployment by technology would be:<br>HWR: 2.5 percent<br>MHTGR: 2.5 percent<br>ALWR: 2.7 percent<br>APT: 2.8 percent | • Unemployment in the economic study area would decrease from 4.8 percent (the projected baseline) to 4.6 percent to 4.5 percent during full operation. The estimated unemployment by technology would be:<br>HWR: 4.5 percent<br>MHTGR: 4.6 percent<br>ALWR: 4.6 percent<br>APT: 4.6 percent |
| • Population and housing demand within the region of influence would increase by 2 percent for all technologies during operation. | • Population and housing demand within the region of influence would increase by no more than 1 percent for all technologies during operation. | • Population and housing demand within the region of influence would not increase by more than 1 percent for all technologies during operation. | • Population and housing demand within the region of influence would not increase by more than 2 percent for all technologies, except APT where it would not increase by more than 1 percent, during operation. | • Population and housing demand within the region of influence would not increase by more than 1 percent for all technologies during operation. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 15 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • Per capita income in the economic study area would increase by an annual average of approximately 1 percent during peak construction and full operation for every technology except HWR, which would increase by 1 percent to 2 percent during peak construction and 2 percent during full operation. | • Per capita income in the economic study area would increase by an annual average of approximately 1 percent during peak construction and full operation for all technologies. | • Per capita income in the economic study area would increase by an annual average of 1 percent during peak construction and full operation for all technologies. | • Per capita income in the economic study area would increase by an annual average of approximately 1 percent during peak construction and full operation for HWR and APT, and less than 1 percent during peak construction and full operation for MHTGR and ALWR. | • Per capita income in the economic study area would increase by an annual average of approximately 1 percent during peak construction and full operation for all technologies. |
| • With a collocated tritium supply and recycling facility total revenues and expenditures for most region-of-influence counties, cities, and school districts, would increase by an annual average between 2 and less than 1 percent through the year 2005 and between 1 percent and 0 percent through the year 2010 for all technologies except ALWR. For the ALWR, total revenue and expenditure within the region of influence would increase between 4 percent and less than 1 percent in the first 3 years of construction and decrease 1 percent to 2 percent annually through the year 2020. | • With a collocated tritium supply and recycling facility total revenues and expenditures for most region-of-influence counties, cities, and school districts, would increase by an annual average between 1 and 3 percent through the years 2001 and 2005 for the HWR. Total revenue and expenditure annual average increases of less than 1 percent to 2 percent between 2001 and 2005 would be expected for the MHTGR and APT. Annual average increases of less than 1 percent to 4 percent between 2001 and 2005 would be expected for the ALWR. | • With a collocated tritium supply and recycling facility total revenues and expenditures for most region-of-influence counties, cities, and school districts, would increase by an annual average of approximately 1 percent or less through 2010. Between 2010 and 2020 total revenue and expenditures are both expected to increase by an annual average of less than 1 percent for all technologies. | • With a collocated tritium supply and recycling facility total revenues and expenditures for most region-of-influence counties, cities, and school districts, would increase by an annual average of 1 percent through the year 2005 then remain flat until the year 2010 for HWR and MHTGR. For the ALWR, total revenue and expenditure within the region of influence would increase by an annual average of 1 percent to 2 percent to year 2005, and then decrease by 1 percent until year 2010. For all three reactor technologies (HWR, MHTGR, and ALWR) total revenues and expenditures are expected to increase at an annual average of less than 1 percent between 2010 and 2020. | • With a tritium supply and upgraded recycling facility total revenues and expenditures for most region-of-influence counties, cities, and school districts, would increase by an annual average of less than 1 percent through the year 2020 for all technologies except ALWR. For the ALWR, total revenue and expenditure within the region of influence would increase between 2 percent and less than 1 percent through 2005 and remain flat until 2010. Between 2010 and 2020, total revenue and expenditures would increase by an annual average of less than 1 percent. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 16 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| Total revenues and expenditures for all technologies would increase by annual averages of less than 1 percent through the year 2020. | Revenue and expenditure annual average would increase 1 percent through the year 2010 while increases of less than 1 percent through the year 2020 would be expected for all technologies. | | For APT total revenues and expenditures within the region-of-influence are projected to increase by an annual average of less than 1 percent through 2020. | |
| • Traffic conditions would worsen slightly due to increased traffic and congestion on site access roads, particularly on U.S. Route 20/26, the primary access route. | • Traffic conditions would worsen slightly due to increased traffic and congestion on site access roads, particularly on Mercury Highway, the primary access route. | • Traffic conditions would worsen slightly due to increased traffic and congestion on site access roads, particularly on Bear Creek Road, the primary access route. | • Traffic conditions would worsen slightly on site access roads due to increased traffic and congestion, particularly on Farm-to-Market Road 683, the primary access route. | • Traffic conditions would worsen slightly due to increased traffic and congestion on site access roads, particularly on State Route 125, the primary access route. |
| | | **Tritium Supply Alone** | | |
| • The effects on employment and income for a tritium supply alone would be slightly less than the effects of collocation with recycling for all technologies. | • The effects on employment and income for a tritium supply alone would be slightly less than the effects of collocation with recycling for all technologies. | • The effects on employment and income for a tritium supply alone would be slightly less than the effects of collocation with recycling for all technologies. | • The effects on employment and income over for a tritium supply alone would be slightly less than the effects of collocation with recycling for all technologies. | • No tritium supply alone. |
| • Population and housing demands in the region-of-influence during construction of a tritium supply alone would not increase by more than 1 percent to 8 percent over No Action. The increase by technology would be:<br><br>HWR: 4 percent<br>MHTGR: 4 percent<br>ALWR: 8 percent<br>APT: 1 percent | • Population and housing demands in the region-of-influence during construction of a tritium supply alone would not increase by more than 1 percent over No Action for all technologies except the ALWR, which would increase by 2 percent. | • Population and housing demands in the region-of-influence during construction of a tritium supply alone would not increase by more than 1 percent over No Action for all technologies. | • Population and housing demands in the region-of-influence during construction of a tritium supply alone would not increase by more than 1 percent to 6 percent over No Action. The increase by technology would be:<br><br>HWR: 3 percent<br>MHTGR: 2 percent<br>ALWR: 6 percent<br>APT: 1 percent | • No tritium supply alone. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 17 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • Population and housing demands in the region-of-influence during operation of a tritium supply alone would not increase by more than 1 percent over No Action for all technologies. | • Population and housing demands in the region-of-influence during operation of a tritium supply alone would not increase by more than 1 percent over No Action for all technologies. | • Population and housing demands in the region-of-influence during operation of a tritium supply alone would not increase by more than 1 percent over No Action for all technologies. | • Population and housing demands in the region-of-influence during operation of a tritium supply alone would not increase by more than 1 percent over No Action for all technologies. | • No tritium supply alone. |
| • Revenues and expenditures with tritium supply alone would increase for all region-of-influence county, city and school districts, but these increases would be less than collocating with recycling for all technologies. | • Revenues and expenditures with tritium supply alone would increase for all region-of-influence county, city and school districts, but these increases would be less than collocating with recycling for all technologies. | • Revenues and expenditures with tritium supply alone would increase for all region-of-influence county, city and school districts, but these increases would be less than collocating with recycling for all technologies. | • Revenues and expenditures with tritium supply alone would increase for all region-of-influence county, city and school districts, but these increases would be less than collocating with recycling for all technologies. | |
| • The effects on site access routes for a tritium supply alone would be slightly less than collocation with recycling for all technologies. | • The effects on site access routes for a tritium supply alone would be slightly less than collocation with recycling for all technologies. | • The effects on site access routes for a tritium supply alone would be slightly less than collocation with recycling for all technologies. | • The effects on site access routes for a tritium supply alone would be slightly less than collocation with recycling for all technologies. | |
| **Radiological and Hazardous Chemical Impacts During Normal Operation—No Action** | | | | |
| • Under No Action for emissions of radiation the dose to the maximally exposed member of the public from 1 year of operation is $6.0 \times 10^{-3}$ mrem. The risk of fatal cancer to the maximally exposed members of the public from 40 years of operation is $1.2 \times 10^{-7}$. | • Under No Action for emissions of radiation the dose to the maximally exposed member of the public from 1 year of operation is 0.04 mrem. The risk of fatal cancer to the maximally exposed members of the public from 40 years of operation is $8.1 \times 10^{-7}$. | • Under No Action for emissions of radiation the dose to the maximally exposed member of the public from 1 year of operation is 3.9 mrem from atmospheric release and 14 mrem from liquid release. The risk of fatal cancer to the maximally exposed members of the public from 40 years of operation is $7.8 \times 10^{-5}$ and $2.7 \times 10^{-4}$ respectively. | • Under No Action for emissions of radiation the dose to the maximally exposed member of the public from 1 year of operation is $1.3 \times 10^{-3}$ mrem. The risk of fatal cancer to the maximally exposed members of the public from 40 years of operation is $2.6 \times 10^{-8}$. | • Under No Action for emissions of radiation the dose to the maximally exposed member of the public from 1 year of operation is 2.8 mrem from atmospheric release and 0.077 from liquid release. The risk of fatal cancer to the maximally exposed members of the public from 40 years of operation is $5.6 \times 10^{-5}$ and $1.5 \times 10^{-6}$ respectively. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 18 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **No Action** | | |
| • The population dose of 0.037 person-rem from total site operations in 2030 would result in $7.4 \times 10^{-4}$ fatal cancer over 40 years of operation. | • The population dose of $8.2 \times 10^{-3}$ person-rem from total site operations in 2030 would result in $1.6 \times 10^{-4}$ fatal cancer over 40 years of operation. | • The population dose of 57 person-rem from total site operations in 2030 would result in 1.1 fatal cancer over 40 years of operation. | • The population dose of $5.7 \times 10^{-4}$ person-rem from total site operations in 2030 would result in $1.1 \times 10^{-5}$ fatal cancer over 40 years of operation. | • The population dose of 250 person-rem from total site operations in 2030 would result in 4.9 fatal cancers over 40 years of operation. |
| • Under No Action the average annual dose to a site worker is 30 mrem with a risk of fatal cancer of $4.8 \times 10^{-4}$ from 40 years of operation. The annual dose of 220 person-rem to total site workforce would result in 3.5 fatal cancers over 40 years of operation. | • Under No Action the average annual dose to a site worker is 5 mrem with a risk of fatal cancer of $7.8 \times 10^{-5}$ from 40 years of operation. The annual dose of 3 person-rem to total site workforce would result in 0.048 fatal cancer over 40 years of operation. | • Under No Action the average annual dose to a site worker is 17 mrem with a risk of fatal cancer of $2.8 \times 10^{-4}$ from 40 years of operation. The annual dose of 320 person-rem to total site workforce would result in 5.1 fatal cancers over 40 years of operation. | • Under No Action the average annual dose to a site worker is 15 mrem with a risk of fatal cancer of $2.4 \times 10^{-4}$ from 40 years of operation. The annual dose of 37 person-rem to total site workforce would result in 0.59 fatal cancers over 40 years of operation. | • Under No Action the average annual dose to a site worker is 32 mrem with a risk of fatal cancer of $5.2 \times 10^{-4}$ from 40 years of operation. The annual dose of 480 person-rem to total site workforce would result in 7.7 fatal cancers over 40 years of operation. |
| • Under No Action for emission of hazardous chemicals the chemical Hazard Index is $1.7 \times 10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.021 with no cancer risk. | • Under No Action for emission of hazardous chemicals the chemical Hazard Index is 0 with no cancer risk to the maximally exposed member of the public or site worker. | • Under No Action for emission of hazardous chemicals the chemical Hazard Index is 0.36 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.26 with no cancer risk. | • Under No Action for emission of hazardous chemicals the chemical Hazard Index is 0.03 with a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 with a cancer risk of 0.01. The site worker cancer risk exceeds the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • Under No Action for emission of hazardous chemicals the chemical Hazard Index is 0.70 with a cancer risk of $3.2 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is $5.9 \times 10^{-3}$. The Hazard Index value for the public is within regulatory limits, however, the worker Hazard Index exceeds OSHA's action level of 1.0. The cancer risk to both the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 19 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The dose to the maximally exposed member of the public from total site operations with a collocated tritium supply and recycling facility for 1 year would range from 0.11 to 0.36 mrem from atmospheric releases. The associated risk of fatal cancer from 40 years of operation would range from $2.3x10^{-6}$ to $7.3x10^{-6}$. The annual dose and associated (risk of fatal cancer from 40 years of operation) by technology would be:<br>HWR: 0.29 mrem ($5.9x10^{-6}$)<br>MHTGR: 0.19 mrem ($3.8x10^{-6}$)<br>Large and Small ALWR: 0.36 mrem ($7.3x10^{-6}$)<br>APT (He-3): 0.11 mrem ($2.3x10^{-6}$)<br>APT (SILC): 0.16 mrem ($3.3x10^{-6}$) | • The dose to the maximally exposed member of the public from total site operations with a collocated tritium supply and recycling facility for 1 year would range from 0.13 to 0.40 mrem from atmospheric releases. The associated risk of fatal cancer from 40 years of operation would range from $2.6x10^{-6}$ to $8.0x10^{-6}$. The annual dose and associated (risk of fatal cancer from 40 years of operation) by technology would be:<br>HWR: 0.31 mrem ($6.2x10^{-6}$)<br>MHTGR: 0.21 mrem ($4.1x10^{-6}$)<br>Large and Small ALWR: 0.40 mrem ($8.0x10^{-6}$)<br>APT (He-3): 0.13 mrem ($2.6x10^{-6}$)<br>APT (SILC): 0.18 mrem ($3.6x10^{-6}$) | • The dose to the maximally exposed member of the public from total site operations with a collocated tritium supply and recycling facility for 1 year would range from 4.3 to 8.8 mrem from atmospheric release. The associated risk of fatal cancer from 40 years of operation would range from $8.6x10^{-5}$ to $1.8x10^{-4}$. The annual dose and associated (risk of fatal cancer from 40 years of operation) by technology would be:<br>HWR: 7.1 mrem ($1.4x10^{-4}$)<br>MHTGR: 5.7 mrem ($1.1x10^{-4}$)<br>Large ALWR: 8.8 mrem ($1.8x10^{-4}$)<br>Small ALWR: 7.6 mrem ($1.5x10^{-4}$)<br>APT (He-3): 4.3 mrem ($8.6x10^{-5}$)<br>APT (SILC): 5.0 mrem ($1.0x10^{-4}$) | • The dose to the maximally exposed member of the public from total site operations with a collocated tritium supply and recycling facility for 1 year would range from 1.4 to 4.9 mrem from atmospheric releases. The associated risk of fatal cancer from 40 years of operation would range from $2.9x10^{-5}$ to $9.8x10^{-5}$. The annual dose and associated (risk of fatal cancer from 40 years of operation) by technology would be:<br>HWR: 3.8 mrem ($7.6x10^{-5}$)<br>MHTGR: 2.4 mrem ($4.8x10^{-5}$)<br>Large ALWR: 4.9 mrem ($9.8x10^{-5}$)<br>Small ALWR: 4.8 mrem ($9.6x10^{-5}$)<br>APT (He-3): 1.4 mrem ($2.9x10^{-5}$)<br>APT (SILC): 2.1 mrem ($4.2x10^{-5}$) | • The dose to the maximally exposed member of the public from total site operations with a collocated tritium supply and upgraded recycling facility for 1 year would range from 2.5 to 3.9 mrem from atmospheric release. The associated risk of fatal cancer from 40 years of operation would range from $4.9x10^{-5}$ to $7.8x10^{-5}$. The annual dose and associated (risk of fatal cancer from 40 years of operation) by technology would be:<br>HWR: 3.4 mrem($6.9x10^{-5}$)<br>MHTGR: 3.0 mrem ($5.9x10^{-5}$)<br>Large ALWR: 3.9 mrem ($7.8x10^{-5}$)<br>Small ALWR: 3.6 mrem ($7.1x10^{-5}$)<br>APT (He-3): 2.5 mrem ($4.9x10^{-5}$)<br>APT (SILC): 2.8 mrem ($5.6x10^{-5}$) |
| • No liquid releases. | • No liquid releases. | • The dose to the maximally exposed member of the public from total site operation with a collocated tritium supply and recycling facility for 1 year would be 14 mrem from liquid release, the associated risk of fatal cancer from 40 years of operation would be $2.7x10^{-4}$ for all technologies, except for the ALWRs ($2.8x10^{-4}$). | • No liquid releases. | • The dose to the maximally exposed member of the public from total site operation with a tritium supply and upgraded recycling facility for 1 year would range from 0.077 to 0.26 mrem from liquid release, the associated risk of fatal cancer from 40 years of operation would range from $1.5x10^{-6}$to $5.3x10^{-6}$. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 20 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| | | | | The annual dose and associated (risk of fatal cancer from 40 years of operation) by technology would be:<br>HWR: 0.16 mrem ($3.3x10^{-6}$)<br>MHTGR: 0.077 mrem ($1.5x10^{-6}$)<br>Large ALWR: 0.16 mrem ($3.3x10^{-6}$)<br>Small ALWR: 0.26 mrem ($5.3x10^{-6}$)<br>APT (for either target system): 0.077 mrem ($1.5x10^{-6}$) |
| • The 50-mile population annual dose from total site operations in 2030 would range from 23 to 73 person-rem and could result in 0.45 to 1.5 fatal cancers from 40 years of operation. The annual dose and (fatal cancers from 40 years of operation) by technology would be:<br>HWR: 53 person-rem (1.1)<br>MHTGR: 37 person-rem (0.73)<br>Large ALWR: 73 person-rem (1.5)<br>Small ALWR: 71 person-rem (1.4)<br>APT (He-3): 23 person-rem (0.45)<br>APT (SILC): 32 person-rem (0.64) | • The 50-mile population annual dose from total site operations in 2030 would range from 0.08 to 0.25 person-rem and could result in $1.6x10^{-3}$ to $5.1x10^{-3}$ fatal cancers from 40 years of operation. The annual dose and (fatal cancers from 40 years of operation) by technology would be:<br>HWR: 0.20 person-rem ($4.0x10^{-3}$)<br>MHTGR: 0.13 person-rem($2.6x10^{-3}$)<br>Large ALWR: 0.24 person-rem ($4.9x10^{-3}$)<br>Small ALWR: 0.25 person-rem ($5.1x10^{-3}$)<br>APT (He-3): 0.08 person-rem($1.6x10^{-3}$)<br>APT (SILC): 0.11 person-rem($2.3x10^{-3}$) | • The 50-mile population annual dose from total site operations in 2030 would range from 68 to 90 person-rem and could result in 1.4 to 1.8 fatal cancers from 40 years of operation. The annual dose and (fatal cancers from 40 years of operation) by technology would be:<br>HWR: 82 person-rem (1.6)<br>MHTGR: 76 person-rem (1.5)<br>Large ALWR: 90 person-rem (1.8)<br>Small ALWR: 87 person-rem (1.7)<br>APT (He-3): 68 person-rem (1.4 )<br>APT (SILC): 73 person-rem (1.5) | • The 50-mile population annual dose from total site operations in 2030 would range from 9.2 to 37 person-rem and could result in 0.18 to 0.73 fatal cancer from 40 years of operation. The annual dose and (fatal cancer from 40 years of operation) by technology would be:<br>HWR: 28 person-rem (0.55)<br>MHTGR: 16 person-rem (0.31)<br>Large ALWR: 37 person-rem (0.73)<br>Small ALWR: 35 person-rem (0.69)<br>APT (He-3): 9.2 person-rem (0.18)<br>APT (SILC): 14 person-rem (0.27) | • The 50-mile population annual dose from total site operations in 2030 would range from 220 to 340 person-rem and could result in 4.4 to 6.8 fatal cancers from 40 years of operation. The annual dose and (fatal cancers from 40 years of operation) by technology would be:<br>HWR: 300 person-rem (6.1)<br>MHTGR: 260 person-rem (5.2)<br>Large ALWR: 340 person-rem (6.8)<br>Small ALWR: 310 person-rem (6.2)<br>APT (He-3): 220 person-rem (4.4)<br>APT (SILC): 250 person-rem (4.9) |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 21 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The average annual dose to a site worker that is associated with total site operations would range from 31 to 49 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $5.0x10^{-4}$ to $7.9x10^{-4}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 33 mrem ($5.2x10^{-4}$)<br>MHTGR: 31 mrem ($5.0x10^{-4}$)<br>Large ALWR: 49 mrem ($7.9x10^{-4}$)<br>Small ALWR: 41 mrem ($6.6x10^{-4}$)<br>APT (He-3) : 34 mrem ($5.4x10^{-4}$)<br>APT (SILC): 34 mrem ($5.5x10^{-4}$) | • The average annual dose to a site worker that is associated with total site operations would range from 26 to 140 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $4.2x10^{-4}$ to $2.3x10^{-3}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 34 mrem ($5.4x10^{-4}$)<br>MHTGR: 26 mrem ($4.2x10^{-4}$)<br>Large ALWR: 140 mrem ($2.3x10^{-3}$)<br>Small ALWR: 92 mrem ($1.5x10^{-3}$)<br>APT (He-3): 43 mrem ($6.9x10^{-4}$)<br>APT (SILC): 44 mrem ($7.0x10^{-4}$) | • The average annual dose to a site worker that is associated with total site operations would range from 18 to 26 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $2.9x10^{-4}$ to $4.2x10^{-4}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 19 mrem ($3.0x10^{-4}$)<br>MHTGR: 18 mrem ($2.9x10^{-4}$)<br>Large ALWR: 26 mrem ($4.2x10^{-4}$)<br>Small ALWR: 22 mrem ($3.6x10^{-4}$)<br>APT (for either target system): 20 mrem ($3.1x10^{-4}$) | • The average annual dose to a site worker that is associated with total site operations would range from 22 to 68 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $3.5x10^{-4}$ to $1.1x10^{-3}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology would be:<br>HWR: 25 mrem ($4.0x10^{-4}$)<br>MHTGR: 22 mrem ($3.5x10^{-4}$)<br>Large ALWR: 68 mrem ($1.1x10^{-3}$)<br>Small ALWR: 46 mrem ($7.4x10^{-4}$)<br>APT (for either target system): 29 mrem ($4.6x10^{-4}$) | • The average annual dose to a site worker that is associated with total site operations would range from 33 to 42 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $5.3x10^{-4}$ to $6.7x10^{-4}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology would be:<br>HWR: 34 mrem ($5.4x10^{-4}$)<br>MHTGR: 33 mrem ($5.3x10^{-4}$)<br>Large ALWR: 42 mrem ($6.7x10^{-4}$)<br>Small ALWR: 38 mrem ($6.1x10^{-4}$)<br>APT (He-3): 34 mrem ($5.4x10^{-4}$)<br>APT (SILC): 34 mrem ($5.4x10^{-4}$) |
| • The annual dose to the total site workforce would range from 250 to 392 person-rem and could result in 4.0 to 6.3 fatal cancers over 40 years of operation. The annual dose and (fatal cancers from 40 years of operations) by technology would be: | • The annual dose to the total site workforce would range from 33 to 180 person-rem and could result in 0.53 to 2.8 fatal cancers over 40 years of operation. The annual dose and (fatal cancers from 40 years of operations) by technology would be: | • The annual dose to the total site workforce would range from 350 to 490 person-rem and could result in 5.6 to 7.9 fatal cancers over 40 years of operation. The annual dose and (fatal cancers from 40 years of operations) by technology would be: | • The annual dose to the total site workforce would range from 67 to 210 person-rem and could result in 1.1 to 3.3 fatal cancers over 40 years of operation. The annual dose and (fatal cancers from 40 years of operations) by technology would be: | • The annual dose to the total site workforce would range from 510 to 650 person-rem and could result in 8.2 to 10 fatal cancers over 40 years of operation. The annual dose and (fatal cancers from 40 years of operations) by technology would be: |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 22 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| HWR: 261 person-rem (4.2)<br>MHTGR: 250 person-rem (4.0)<br>Large ALWR: 392 person-rem (6.3)<br>Small ALWR: 322 person-rem (5.2)<br>APT (He-3): 273 person-rem (4.4)<br>APT (SILC): 274 person-rem (4.4) | HWR: 44 person-rem (0.70)<br>MHTGR: 33 person-rem (0.53)<br>Large ALWR: 180 person-rem (2.8)<br>Small ALWR: 100 person-rem (1.7)<br>APT (He-3): 56 person-rem (0.90)<br>APT (SILC): 57 person-rem (0.91) | HWR: 360 person-rem (5.8)<br>MHTGR: 350 person-rem (5.6)<br>Large ALWR: 490 person-rem (7.9)<br>Small ALWR: 420 person-rem (6.7)<br>APT (He-3): 372 person-rem (6.0)<br>APT (SILC): 373 person-rem (6.0) | HWR: 78 person-rem (1.2)<br>MHTGR: 67 person-rem (1.1)<br>Large ALWR: 210 person-rem (3.3)<br>Small ALWR: 140 person-rem (2.2)<br>APT (He-3): 90 person-rem (1.4)<br>APT (SILC): 91 person-rem (1.5) | HWR: 520 person-rem (8.3)<br>MHTGR: 510 person-rem (8.2)<br>Large ALWR: 650 person-rem (10)<br>Small ALWR: 580 person-rem (9.3)<br>APT (He-3): 533 person-rem (8.5)<br>APT (SILC): 534 person-rem (8.5) |
| • All doses to the public and site workers are within regulatory limits. | • All doses to the public and site workers are within regulatory limits. | • All doses to the public and site workers are within regulatory limits. | • All doses to the public and site workers are within regulatory limits. | • All doses to the public and site workers are within regulatory limits. |
| • For chemicals the Hazard Index ranges from $1.8x10^{-4}$ to $6.3x10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index ranges from 0.021 to 0.13 with no cancer risk. All values are within regulatory limits. The Hazard Indexes by technology would be: | • For chemicals the Hazard Index ranges from $1.8x10^{-7}$ to $7.7x10^{-3}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index ranges from $3.4x10^{-5}$ to 0.038 with no cancer risk. All values are within regulatory limits. The Hazard Indexes by technology would be: | • For chemicals the Hazard Index ranges from 0.36 to 0.38 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index ranges from 0.35 to 0.26 with no cancer risk. All values are within regulatory limits. The Hazard Indexes by technology would be: | • For chemicals the Hazard Index ranges from 0.030 to 0.036 with a cancer risk of $1.1x10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 with a cancer risk of 0.010. The Hazard Index values are within regulatory limits, but the cancer risks to both the public and site worker exceed the typical threshold of regulatory concern of $1.0x10^{-6}$. The Hazard Indexes by technology would be: | • For chemicals the Hazard Index is 0.7 with a cancer risk of $3.3x10^{-5}$ to the maximally exposed member of the public for all technologies. The site worker Hazard Index is 1.8 with a cancer risk of $5.9x10^{-3}$ for all technologies . The Hazard Index value for the public is within regulatory limits, however the Hazard Index value to the worker exceeds the action level of 1.0 based on OSHA's exposure limits. Cancer risks to the public and site workers both exceed the typical threshold of regulatory concern of $1.0x10^{-6}$. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 23 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| Public<br>HWR: $2.1 \times 10^{-4}$<br>MHTGR: $1.8 \times 10^{-4}$<br>Large and Small ALWR: $6.3 \times 10^{-4}$<br>APT (for either target system): $1.8 \times 10^{-4}$ | Public<br>HWR: $6.3 \times 10^{-6}$<br>MHTGR: $2.2 \times 10^{-7}$<br>Large and Small ALWR: $7.7 \times 10^{-5}$<br>APT (for either target system): $1.8 \times 10^{-7}$ | Public<br>HWR: 0.36<br>MHTGR: 0.36<br>Large and Small ALWR: 0.38<br>APT (for either target system): 0.36 | Public<br>HWR: 0.031<br>MHTGR: 0.030<br>Large and Small ALWR: 0.036<br>APT (for either target system): 0.030 | |
| Worker<br>HWR: 0.031<br>MHTGR: 0.021<br>Large and Small ALWR: 0.13<br>APT (for either target system): 0.021 | Worker<br>HWR: $3.2 \times 10^{-3}$<br>MHTGR: $3.4 \times 10^{-5}$<br>Large and Small ALWR: 0.038<br>APT (for either target system): $3.4 \times 10^{-5}$ | Worker<br>HWR: 0.27<br>MHTGR: 0.32<br>Large and Small ALWR: 0.35<br>APT (for either target system): 0.26 | Worker<br>HWR: 0.49<br>MHTGR: 0.49<br>Large and Small ALWR: 0.49<br>APT (for either target system): 0.49 | |
| **Tritium Supply Alone** | | | | |
| • The annual dose to the maximally exposed member of the public from total site operations would range from 0.0048 to 0.25 mrem. The associated risk of fatal cancer from 40 years of operation would range from $1.0 \times 10^{-7}$ to $5.1 \times 10^{-6}$. The dose and associated (risk of fatal cancer) by technology would be: | • The annual dose to the maximally exposed member of the public from total site operations would range from 0.01 to 0.28 mrem. The associated risk of fatal cancer from 40 years of operation would range from $2.0 \times 10^{-7}$ to $5.6 \times 10^{-6}$. The dose and associated (risk of fatal cancer) by technology would be: | • The annual dose to the maximally exposed member of the public from total site operations would range from 1.5 to 6.0 mrem from atmospheric release. The associated risk of fatal cancer from 40 years of operation would range from $3.0 \times 10^{-5}$ to $1.2 \times 10^{-4}$. The dose and associated (risk of fatal cancer) by technology would be: | • The annual dose to the maximally exposed member of the public from total site operations would range from 0.048 to 3.5 mrem. The associated risk of fatal cancer from 40 years of operation would range from $1.0 \times 10^{-6}$ to $7.0 \times 10^{-5}$. The dose and associated (risk of fatal cancer) by technology would be: | • No tritium supply alone. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 24 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| HWR: 0.18 mrem ($3.7x10^{-6}$)<br>MHTGR: 0.08 mrem ($1.6x10^{-6}$)<br>Large and Small ALWR: 0.25 mrem ($5.1x10^{-6}$)<br>APT (He-3): 0.0048 mrem ($1.0x10^{-7}$)<br>APT (SILC): 0.05 mrem ($1.1x10^{-6}$) | HWR: 0.19 mrem ($3.8x10^{-6}$)<br>MHTGR: 0.09 mrem ($1.7x10^{-6}$)<br>Large and Small ALWR: 0.28 mrem ($5.6x10^{-6}$)<br>APT (He-3): 0.01 mrem ($2.0x10^{-7}$)<br>APT (SILC): 0.06 mrem ($1.2x10^{-6}$) | HWR: 4.3 mrem ($8.4x10^{-5}$)<br>MHTGR: 2.9 mrem ($5.4x10^{-5}$)<br>Large ALWR: 6.0 mrem ($1.2x10^{-4}$)<br>Small ALWR: 4.8 mrem ($9.4x10^{-5}$)<br>APT (He-3): 1.5 mrem ($3.0x10^{-5}$)<br>APT (SILC): 2.2 mrem ($4.4x10^{-5}$) | HWR: 2.4 mrem ($4.8x10^{-5}$)<br>MHTGR: 1.0 mrem ($2.0x10^{-5}$)<br>Large ALWR: 3.5 mrem ($7.0x10^{-5}$)<br>Small ALWR: 3.4 mrem ($6.8x10^{-5}$)<br>APT (He-3): 0.048 mrem ($1.0x10^{-6}$)<br>APT (SILC): 0.7 mrem ($1.4x10^{-5}$) | |
| • No liquid release. | • No liquid release. | • The dose to a maximally exposed member of the public from operation for 1 year would be 14 mrem from liquid release for each technology, and the associated risk of fatal cancer from 40 years of operation would be $2.7x10^{-4}$ for all technologies. | • No liquid release. | • No tritium supply alone. |
| • The 50-mile population dose from total site operations in 2030 would range from 1 to 51 person-rem and could result in 0.01 to 1.1 fatal cancers over 40 years of operation. The dose and (fatal cancers) by technology would be: | • The 50-mile population dose from total site operations in 2030 would range from 0.01 to 0.18 person-rem and could result in $2.0x10^{-4}$ to $3.7x10^{-3}$ fatal cancers over 40 years of operation. The dose and (fatal cancers) by technology would be: | • The 50-mile population dose from total site operations in 2030 would range from 57 to 79 person-rem and could result in 1.2 to 1.6 fatal cancers over 40 years of operation. The dose and (fatal cancers) by technology would be: | • The 50-mile population dose from total site operations in 2030 would range from 0.2 to 28 person-rem and could result in $3.9x10^{-3}$ to 0.55 fatal cancers over 40 years of operation. The dose and (fatal cancers) by technology would be: | • No tritium supply alone. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 25 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| HWR: 31 person-rem (0.66)<br>MHTGR: 15 person-rem (0.29)<br>Large ALWR: 51 person-rem (1.1)<br>Small ALWR: 49 person-rem (0.96)<br>APT (He-3): 1 person-rem (0.01)<br>APT (SILC): 10 person-rem (0.2) | HWR: 0.13 person-rem ($2.6x10^{-3}$)<br>MHTGR: 0.06 person-rem ($1.2x10^{-3}$)<br>Large ALWR: 0.17 person-rem ($3.5x10^{-3}$)<br>Small ALWR: 0.18 person-rem ($3.7x10^{-3}$)<br>APT (He-3): 0.01 person-rem ($2.0x10^{-4}$)<br>APT (SILC): 0.04 person-rem ($9.0x10^{-4}$) | HWR: 71 person-rem (1.4)<br>MHTGR: 65 person-rem (1.3)<br>Large ALWR: 79 person-rem (1.6)<br>Small ALWR: 76 person-rem (1.5)<br>APT (He-3): 57 person-rem (1.2)<br>APT (SILC): 62 person-rem (1.3) | HWR: 19 person-rem (0.37)<br>MHTGR: 7 person-rem (0.13)<br>Large ALWR: 28 person-rem (0.55)<br>Small ALWR: 26 person-rem (0.51)<br>APT (He-3): 0.2 person-rem ($3.9x10^{-3}$)<br>APT (SILC): 5 person-rem (0.09) | |
| • The average annual dose to a site worker that is associated with total site operations would range from 33 to 52 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $5.3x10^{-4}$ to $8.3x10^{-4}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 34 mrem ($5.4x10^{-4}$)<br>MHTGR: 33 mrem ($5.3x10^{-4}$)<br>Large ALWR: 52 mrem ($8.3x10^{-4}$)<br>Small ALWR: 43 mrem ($6.9x10^{-4}$)<br>APT (He-3): 36 mrem ($5.7x10^{-4}$)<br>APT (SILC): 36 mrem ($5.8x10^{-4}$) | • The average annual dose to a site worker that is associated with total site operations would range from 37 to 220 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $6.0x10^{-4}$ to $3.5x10^{-3}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 47 mrem ($7.5x10^{-4}$)<br>MHTGR: 37 mrem ($6.0x10^{-4}$)<br>Large ALWR: 220 mrem ($3.5x10^{-3}$)<br>Small ALWR: 130 mrem ($2.2x10^{-3}$)<br>APT (He-3): 60 mrem ($9.7x10^{-4}$)<br>APT (SILC): 62 mrem ($9.9x10^{-4}$) | • The average annual dose to a site worker that is associated with total site operations would range from 19 to 26 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $3.0x10^{-4}$ to $4.3x10^{-4}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 19 mrem ($3.0x10^{-4}$)<br>MHTGR: 19 mrem ($3.0x10^{-4}$)<br>Large ALWR: 26 mrem ($4.3x10^{-4}$)<br>Small ALWR: 23 mrem ($3.7x10^{-4}$)<br>APT (for either target system): 20 mrem ($3.1x10^{-4}$) | • The average annual dose to a site worker that is a resulting with total site operations would range from 24 to 78 mrem with a resulting risk of fatal cancer from 40 years of operation ranging from $2.9x10^{-4}$ to $1.3x10^{-3}$. The dose and (fatal cancer risk) that are associated with total site operations, including the following technology, would be:<br>HWR: 28 mrem ($4.5x10^{-4}$)<br>MHTGR: 24 mrem ($3.9x10^{-4}$)<br>Large ALWR: 78 mrem ($1.3x10^{-3}$)<br>Small ALWR: 53 mrem ($8.6x10^{-4}$)<br>APT (for either target system): 32 mrem ($5.1x10^{-4}$) | • No tritium supply alone. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 26 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • The annual dose to the total site workforce would range from 250 to 390 person-rem and could result in 4.0 to 6.3 fatal cancers over 40 years of operation. The dose and (fatal cancers) by each technology would be:<br>HWR: 260 person-rem (4.2)<br>MHTGR: 250 person-rem (4.0)<br>Large ALWR: 390 person-rem (6.3)<br>Small ALWR: 320 person-rem (5.2)<br>APT (for either target system): 270 person-rem (4.4) | • The annual dose to the total site workforce would range from 42 to 180 person-rem and could result in 0.67 to 2.8 fatal cancers over 40 years of operation. The dose and (fatal cancers) by each technology would be:<br>HWR: 42 person-rem (0.67)<br>MHTGR: 31 person-rem (0.50)<br>Large ALWR: 180 person-rem (2.8)<br>Small ALWR: 98 person-rem (1.7)<br>APT (He-3): 54 person-rem (0.87)<br>APT (SILC): 55 person-rem (0.88) | • The annual dose to the total site workforce would range from 350 to 490 person-rem and could result in 5.6 to 7.9 fatal cancers over 40 years of operation. The dose and (fatal cancers) by each technology would be:<br>HWR: 360 person-rem (5.8)<br>MHTGR: 350 person-rem (5.6)<br>Large ALWR: 490 person-rem (7.9)<br>Small ALWR: 420 person-rem (6.7)<br>APT (for either target system): 370 person-rem 6.0 | • The annual dose to the total site workforce would range from 65 to 210 person-rem and could result in 1.1 to 3.3 fatal cancers over 40 years of operation. The dose and (fatal cancers) by each technology would be:<br>HWR: 76 person-rem (1.2)<br>MHTGR: 65 person-rem (1.1)<br>Large ALWR: 210 person-rem (3.3)<br>Small ALWR: 140 person-rem (2.2)<br>APT (He-3): 88 person-rem (1.4)<br>APT (SILC): 89 person-rem (1.5) | • No tritium supply alone. |
| • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • No tritium supply alone. |
| • For collocation relative percent reduction of the Hazard Index to the maximally exposed member of the public and the site worker Hazard Index with no cancer risk would be reduced by the below listed percentages for each technology (all values are within regulatory limits): | • For collocation relative percent reduction of the Hazard Index to the maximally exposed member of the public and the site worker Hazard Index with no cancer risk would be reduced by the below listed percentages for each technology (all values are within regulatory limits): | • For collocation relative percent reduction of the Hazard Index to the maximally exposed member of the public and the site worker Hazard Index with no cancer risk would be reduced by 0.01 percent for all technologies (all values are within regulatory limits): | • For collocation relative percent reduction of the Hazard Index to the maximally exposed member of the public and the site worker Hazard Index with no change in either of the cancer risk values would be reduced by the below listed percentages for each technology. | • No tritium supply alone. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 27 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| | | | The HI values are within regulatory health limits, the cancer risks to the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$: | |
| Public<br>HWR: 0.3<br>MHTGR: 0.03<br>ALWR: 0.01<br>APT: 0.03 | Public<br>HWR: 1.4<br>MHTGR: 41<br>ALWR: 0.1<br>APT: 51 | Public<br>HWR: 0.01<br>MHTGR: 0.01<br>ALWR: 0.01<br>APT: 0.01 | Public<br>HWR: 10.3<br>MHTGR: 10.6<br>ALWR: 9.3<br>APT: 10.6 | |
| Worker<br>HWR: 0.02<br>MHTGR: 0.2<br>ALWR: 0.04<br>APT: 0.2 | Worker<br>HWR: 0.5<br>MHTGR: 50<br>ALWR: 0.04<br>APT: 50 | Worker<br>HWR: 0.02<br>MHTGR: 0.01<br>ALWR: 0.01<br>APT: 0.02 | Worker<br>HWR: 0.003<br>MHTGR: 0.003<br>ALWR: 0.003<br>APT: 0.003 | |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 28 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Radiological Impacts from Accidents—Collocated Tritium Supply and Recycling** | | | | |
| • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents associated with operation of a tritium supply and upgraded recycling facility would be: |
| Dose (rem)<br>HWR: 0.020<br>MHTGR: 0.022<br>Large ALWR: 5.1<br>Small ALWR: 0.23<br>APT: negligible | Dose (rem)<br>HWR: $8.4 \times 10^{-3}$<br>MHTGR: $9.1 \times 10^{-3}$<br>Large ALWR: 2.3<br>Small ALWR: 0.098<br>APT: negligible | Dose (rem)<br>HWR: 0.14<br>MHTGR: 0.18<br>Large ALWR: 44<br>Small ALWR: 1.9<br>APT: negligible | Dose (rem)<br>HWR: 0.015<br>MHTGR: 0.016<br>Large ALWR: 3.9<br>Small ALWR: 0.18<br>APT: negligible | Dose (rem)<br>HWR: 0.046<br>MHTGR: 0.059<br>Large ALWR: 14<br>Small ALWR: 0.64<br>APT: negligible |
| Cancer Risk (per year)<br>HWR: $9.9 \times 10^{-8}$<br>MHTGR: $1.1 \times 10^{-7}$<br>Large ALWR: $2.5 \times 10^{-6}$<br>Small ALWR: $1.1 \times 10^{-7}$<br>APT: negligible | Cancer Risk (per year)<br>HWR: $4.2 \times 10^{-8}$<br>MHTGR: $4.6 \times 10^{-8}$<br>Large ALWR: $1.1 \times 10^{-6}$<br>Small ALWR: $4.9 \times 10^{-8}$<br>APT: negligible | Cancer Risk (per year)<br>HWR: $6.8 \times 10^{-7}$<br>MHTGR: $9.2 \times 10^{-7}$<br>Large ALWR: $4.4 \times 10^{-5}$<br>Small ALWR: $9.7 \times 10^{-7}$<br>APT: negligible | Cancer Risk (per year)<br>HWR: $7.4 \times 10^{-8}$<br>MHTGR: $8.1 \times 10^{-8}$<br>Large ALWR: $2.0 \times 10^{-6}$<br>Small ALWR: $8.9 \times 10^{-8}$<br>APT: negligible | Cancer Risk (per year)<br>HWR: $2.3 \times 10^{-7}$<br>MHTGR: $3.0 \times 10^{-7}$<br>Large ALWR: $7.1 \times 10^{-6}$<br>Small ALWR: $3.2 \times 10^{-7}$<br>APT: negligible |
| Cancer Fatality<br>HWR: $9.9 \times 10^{-6}$<br>MHTGR: $1.1 \times 10^{-5}$<br>Large ALWR: $2.5 \times 10^{-3}$<br>Small ALWR: $1.1 \times 10^{-4}$<br>APT: negligible | Cancer Fatality<br>HWR: $4.2 \times 10^{-6}$<br>MHTGR: $4.6 \times 10^{-6}$<br>Large ALWR: $1.1 \times 10^{-3}$<br>Small ALWR: $4.9 \times 10^{-5}$<br>APT: negligible | Cancer Fatality<br>HWR: $6.8 \times 10^{-5}$<br>MHTGR: $9.2 \times 10^{-5}$<br>Large ALWR: $4.4 \times 10^{-2}$<br>Small ALWR: $9.7 \times 10^{-4}$<br>APT: negligible | Cancer Fatality<br>HWR: $7.4 \times 10^{-6}$<br>MHTGR: $8.1 \times 10^{-6}$<br>Large ALWR: $2.0 \times 10^{-3}$<br>Small ALWR: $8.9 \times 10^{-5}$<br>APT: negligible | Cancer Fatality<br>HWR: $2.3 \times 10^{-5}$<br>MHTGR: $3.0 \times 10^{-5}$<br>Large ALWR: $7.1 \times 10^{-3}$<br>Small ALWR: $3.2 \times 10^{-4}$<br>APT: negligible |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 29 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: |
| Dose (person-rem)<br>HWR: 180<br>MHTGR: 200<br>Large ALWR: $4.5x10^4$<br>Small ALWR: $2.1x10^3$<br>APT: negligible | Dose (person-rems)<br>HWR: 3.2<br>MHTGR: 3.4<br>Large ALWR: 830<br>Small ALWR: 37<br>APT: negligible | Dose (person-rem)<br>HWR: $1.6x10^3$<br>MHTGR: $2.0x10^3$<br>Large ALWR: $4.9x10^4$<br>Small ALWR: $2.2x10^5$<br>APT: negligible | Dose (person-rem)<br>HWR: 52<br>MHTGR: 68<br>Large ALWR: $1.6x10^4$<br>Small ALWR: 730<br>APT: negligible | Dose (rem)<br>HWR: $1.5x10^3$<br>MHTGR: $2.0x10^3$<br>Large ALWR: $4.6x10^5$<br>Small ALWR: $2.1x10^4$<br>APT: negligible |
| Cancer Risk<br>HWR: $9.2x10^{-4}$<br>MHGTR: $1.0x10^{-3}$<br>Large ALWR: 0.023<br>Small ALWR: $1.1x10^{-3}$<br>APT: negligible | Cancer Risk<br>HWR: $1.6x10^{-5}$<br>MHTGR: $1.7x10^{-5}$<br>Large ALWR: $4.1x10^{-4}$<br>Small ALWR: $1.8x10^{-5}$<br>APT: negligible | Cancer Risk<br>HWR: $8.0x10^{-3}$<br>MHTGR: 0.01<br>Large ALWR: 0.24<br>Small ALWR: 0.011<br>APT: negligible | Cancer Risk<br>HWR: $2.6x10^{-4}$<br>MHTGR: $3.4x10^{-4}$<br>Large ALWR: $8.0x10^{-3}$<br>Small ALWR: $3.6x10^{-4}$<br>APT: negligible | Cancer Risk (per year)<br>HWR: $7.4x10^3$<br>MHTGR: 0.01<br>Large ALWR: 0.23<br>Small ALWR: 0.011<br>APT: negligible |
| Cancer Fatality<br>HWR: 0.092<br>MHGTR: 0.10<br>Large ALWR: 23<br>Small ALWR: 1.1<br>APT: negligible | Cancer Fatality<br>HWR: $1.6x10^{-3}$<br>MHTGR: $1.7x10^{-3}$<br>Large ALWR: 0.41<br>Small ALWR: 0.018<br>APT: negligible | Cancer Fatality<br>HWR: 0.8<br>MHTGR: 1.0<br>Large ALWR: 240<br>Small ALWR: 11<br>APT: negligible | Cancer Fatality<br>HWR: 0.026<br>MHTGR: 0.034<br>Large ALWR: 8.0<br>Small ALWR: 0.36<br>APT: negligible | Cancer Fatality<br>HWR: 0.74<br>MHTGR: 1.0<br>Large ALWR: 230<br>Small ALWR: 11<br>APT: negligible |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 30 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents associated with operation of a collocated tritium supply and recycling facility would be: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents associated with operation of a collocated tritium supply and recycling facility would be: |
| Dose (rem)<br>HWR: 41<br>MHTGR: 0.078<br>Large ALWR: 166<br>Small ALWR: 149<br>APT (He-3): $1.3\times10^{-5}$<br>APT (SILC): $1.6\times10^{-4}$ | Dose (rem)<br>HWR: 71<br>MHTGR: 0.14<br>Large ALWR: 284<br>Small ALWR: 266<br>APT (He-3): $2.1\times10^{-5}$<br>APT (SILC): $2.4\times10^{-4}$ | Dose (rem)<br>HWR: $1.3\times10^{3}$<br>MHTGR: 2.5<br>Large ALWR: $5.1\times10^{3}$<br>Small ALWR: $5.3\times10^{3}$<br>APT (He-3): $3.3\times10^{-4}$<br>APT (SILC): $3.3\times10^{-3}$ | Dose (rem)<br>HWR: 426<br>MHTGR: 0.82<br>Large ALWR: $1.7\times10^{3}$<br>Small ALWR: $1.7\times10^{3}$<br>APT (He-3): $1.1\times10^{-4}$<br>APT (SILC): $1.1\times10^{-3}$ | Dose (rem)<br>HWR: 44.5<br>MHTGR: 0.08<br>Large ALWR: 174<br>Small ALWR: 174<br>APT (He-3): $1.1\times10^{-5}$<br>APT (SILC): $1.2\times10^{-4}$ |
| Cancer Risk (per year)<br>HWR: $4.9\times10^{-11}$<br>MHTGR: $1.1\times10^{-13}$<br>Large ALWR: $7.4\times10^{-11}$<br>Small ALWR: $8.6\times10^{-11}$<br>APT (He-3): $1.8\times10^{-10}$<br>APT (SILC): $1.4\times10^{-9}$ | Cancer Risk (per year)<br>HWR: $8.9\times10^{-11}$<br>MHTGR: $2.0\times10^{-13}$<br>Large ALWR: $1.3\times10^{-10}$<br>Small ALWR: $1.5\times10^{-10}$<br>APT (He-3): $3.4\times10^{-14}$<br>APT (SILC): $2.6\times10^{-13}$ | Cancer Risk (per year)<br>HWR: $1.8\times10^{-9}$<br>MHTGR: $4.1\times10^{-12}$<br>Large ALWR: $2.6\times10^{-9}$<br>Small ALWR: $3.2\times10^{-9}$<br>APT (He-3): $6.9\times10^{-13}$<br>APT (SILC): $5.2\times10^{-12}$ | Cancer Risk (per year)<br>HWR: $6.0\times10^{-10}$<br>MHTGR: $1.3\times10^{-12}$<br>Large ALWR: $8.7\times10^{-10}$<br>Small ALWR: $1.0\times10^{-9}$<br>APT (He-3): $2.3\times10^{-13}$<br>APT (SILC): $1.7\times10^{-12}$ | Cancer Risk (per year)<br>HWR: $6.1\times10^{-11}$<br>MHTGR: $1.4\times10^{-13}$<br>Large ALWR: $9.0\times10^{-11}$<br>Small ALWR: $1.1\times10^{-10}$<br>APT (He-3): $2.3\times10^{-14}$<br>APT (SILC): $1.7\times10^{-13}$ |
| Cancer Fatality<br>HWR: $9.9\times10^{-4}$<br>MHTGR: $1.8\times10^{-6}$<br>Large ALWR: $3.7\times10^{-3}$<br>Small ALWR: $4.3\times10^{-3}$<br>APT (He-3): $1.8\times10^{-10}$<br>APT (SILC): $1.4\times10^{-9}$ | Cancer Fatality<br>HWR: $1.8\times10^{-3}$<br>MHTGR: $3.3\times10^{-6}$<br>Large ALWR: $6.7\times10^{-3}$<br>Small ALWR: $7.7\times10^{-3}$<br>APT (He-3): $3.4\times10^{-10}$<br>APT (SILC): $2.6\times10^{-9}$ | Cancer Fatality<br>HWR: 0.04<br>MHTGR: $6.8\times10^{-5}$<br>Large ALWR: 0.13<br>Small ALWR: 0.16<br>APT (He-3): $6.9\times10^{-9}$<br>APT (SILC): $5.2\times10^{-8}$ | Cancer Fatality<br>HWR: $1.2\times10^{-2}$<br>MHTGR: $2.2\times10^{-5}$<br>Large ALWR: 0.04<br>Small ALWR: 0.05<br>APT (He-3): $2.3\times10^{-9}$<br>APT (SILC): $1.7\times10^{-8}$ | Cancer Fatality<br>HWR: $1.2\times10^{-3}$<br>MHTGR: $2.3\times10^{-6}$<br>Large ALWR: $4.6\times10^{-3}$<br>Small ALWR: $5.3\times10^{-3}$<br>APT (He-3): $2.3\times10^{-10}$<br>APT (SILC): $1.7\times10^{-9}$ |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 31 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles would be: |
| Dose (person-rem)<br>HWR: $1.3x10^5$<br>MHTGR: 226<br>Large ALWR: $4.6x10^5$<br>Small ALWR: $5.7x10^5$<br>APT (He-3): 0.018<br>APT (SILC): 0.10 | Dose (person-rem)<br>HWR: $1.3x10^4$<br>MHTGR: 22.7<br>Large ALWR: $4.6x10^4$<br>Small ALWR: $5.7x10^4$<br>APT (He-3): $1.8x10^3$<br>APT (SILC): 0.011 | Dose (person-rem)<br>HWR: $1.0x10^6$<br>MHTGR: $1.9x10^3$<br>Large ALWR: $3.7x10^6$<br>Small ALWR: $4.4x10^6$<br>APT (He-3): 0.18<br>APT (SILC): 1.2 | Dose (rem)<br>HWR: $1.3x10^5$<br>MHTGR: 236<br>Large ALWR: $4.8x10^5$<br>Small ALWR: $5.7x10^5$<br>APT (He-3): 0.022<br>APT (SILC): 0.15 | Dose (rem)<br>HWR: $4.4x10^5$<br>MHTGR: 800<br>Large ALWR: $1.6x10^6$<br>Small ALWR: $2.0x10^6$<br>APT (He-3): 0.068<br>APT (SILC): 0.43 |
| Cancer Risk (per year)<br>HWR: $3.2x10^{-6}$<br>MHTGR: $6.8x10^{-9}$<br>Large ALWR: $4.6x10^{-6}$<br>Small ALWR: $5.6x10^{-6}$<br>APT (He-3): $9.0x10^{-10}$<br>APT (SILC): $5.0x10^{-9}$ | Cancer Risk (per year)<br>HWR: $3.2x10^{-7}$<br>MHTGR: $6.8x10^{-10}$<br>Large ALWR: $4.6x10^{-7}$<br>Small ALWR: $5.7x10^{-7}$<br>APT (He-3): $9.0x10^{-11}$<br>APT (SILC): $5.3x10^{-10}$ | Cancer Risk (per year)<br>HWR: $2.5x10^{-5}$<br>MHTGR: $5.5x10^{-8}$<br>Large ALWR: $3.7x10^{-5}$<br>Small ALWR: $4.5x10^{-5}$<br>APT (He-3): $9.0x10^{-9}$<br>APT (SILC): $6.1x10^{-8}$ | Cancer Risk (per year)<br>HWR: $3.2x10^{-6}$<br>MHTGR: $7.1x10^{-9}$<br>Large ALWR: $4.8x10^{-5}$<br>Small ALWR: $5.7x10^{-6}$<br>APT (He-3): $1.1x10^{-9}$<br>APT (SILC): $7.5x10^{-9}$ | Cancer Risk (per year)<br>HWR: $1.1x10^{-5}$<br>MHTGR: $2.4x10^{-8}$<br>Large ALWR: $1.6x10^{-5}$<br>Small ALWR: $2.0x10^{-5}$<br>APT (He-3): $3.4x10^{-9}$<br>APT (SILC): $2.2x10^{-8}$ |
| Cancer Fatality<br>HWR: 63.3<br>MHTGR: 0.11<br>Large ALWR: 229<br>Small ALWR: 282<br>APT (He-3): $9.0x10^{-6}$<br>APT (SILC): $5.0x10^{-5}$ | Cancer Fatality<br>HWR: 6.4<br>MHTGR: 0.011<br>Large ALWR: 23<br>Small ALWR: 28.4<br>APT (He-3): $9.0x10^{-7}$<br>APT (SILC): $5.3x10^{-6}$ | Cancer Fatality<br>HWR: 504<br>MHTGR: 0.92<br>Large ALWR: $1.9x10^3$<br>Small ALWR: $2.2x10^3$<br>APT (He-3): $9.0x10^{-5}$<br>APT (SILC): $6.1x10^{-4}$ | Cancer Fatality<br>HWR: 64.4<br>MHTGR: 0.12<br>Large ALWR: 238<br>Small ALWR: 283<br>APT (He-3): $1.1x10^{-5}$<br>APT (SILC): $7.5x10^{-5}$ | Cancer Fatality<br>HWR: 222<br>MHTGR: 0.40<br>Large ALWR: 808<br>Small ALWR: 984<br>APT (He-3): $3.4x10^{-5}$<br>APT (SILC): $2.2x10^{-4}$ |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 32 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Tritium Supply Alone** | | | | |
| • For low to moderate consequences/high probability accidents and high consequence/ low probability accidents associated with the operation of a tritium supply alone, the radiological impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the radiological impacts from supply alone are identical to the collocated tritium supply and recycling. | • For low to moderate consequences/high probability accidents and high consequence/ low probability accidents associated with the operation of a tritium supply alone, the radiological impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the radiological impacts from supply alone are identical to the collocated tritium supply and recycling. | • For low to moderate consequences/high probability accidents and high consequence/ low probability accidents associated with the operation of a tritium supply alone, the radiological impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the radiological impacts from supply alone are identical to the collocated tritium supply and recycling. | • For low to moderate consequences/high probability accidents and high consequence/ low probability accidents associated with the operation of a tritium supply alone, the radiological impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the radiological impacts from supply alone are identical to the collocated tritium supply and recycling. | • No tritium supply alone. |
| **Waste Management—No Action** | | | | |
| • Under No Action, INEL would continue to manage spent nuclear fuel and the following waste types: high-level, TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. | • Under No Action, NTS would continue to manage the following waste types: TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. | • Under No Action, ORR would continue to manage spent nuclear fuel and the following waste types: TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. | • Under No Action, Pantex would continue to manage the following waste types: low-level, mixed low-level, hazardous, and nonhazardous. | • Under No Action, SRS would continue to manage spent nuclear fuel and the following waste types: high-level, TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • For collocated tritium supply and recycling facilities, spent nuclear fuel would be generated by all technologies, except APT. New spent fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change for spent nuclear fuel. | • For collocated tritium supply and recycling facilities, spent nuclear fuel would be generated by all technologies, except APT. New spent fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change for spent nuclear fuel. | • For collocated tritium supply and recycling facilities, spent nuclear fuel would be generated by all technologies, except APT. New spent fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change for spent nuclear fuel. | • For collocated tritium supply and recycling facilities, spent nuclear fuel would be generated by all technologies, except APT. New spent fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change for spent nuclear fuel. | • For collocated tritium supply and upgraded recycling facilities, spent nuclear fuel would be generated by all technologies, except APT. New spent fuel storage facilities would be required. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 33 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • For collocated tritium supply and recycling facilities, liquid LLW would be generated by all technologies except APT in the following quantities: | • For collocated tritium supply and recycling facilities, liquid LLW would be generated for all technologies except APT in the following quantities: | • For collocated tritium supply and recycling facilities, liquid LLW generation would increase for all technologies except APT. The increase over No Action (587,000 GPY) would be: | • For collocated tritium supply and recycling facilities, liquid LLW generation would increase for all technologies except APT. The increase over No Action (400 GPY) would be: | • For collocated tritium supply and upgraded recycling facilities, liquid LLW would be generated for all technologies except APT in the following quantities: |
| HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY<br>Existing/planned treatment facilities may be adequate for all technologies, except the Large ALWR, which would require a new treatment facility. For tritium recycling phaseout at SRS, no change for liquid LLW. | HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY<br>New treatment facilities would be required. For tritium recycling phaseout at SRS, no change for liquid LLW. | HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY<br>New treatment facilities would be required. For tritium recycling phaseout at SRS, no change for liquid LLW. | HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY<br>New treatment facilities would be required. For tritium recycling phaseout at SRS, no change for liquid LLW. | HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY<br>New treatment facilities would be required. |
| • For collocated tritium supply and recycling facilities, solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (5,100 $yd^3$ per year) and the additional LLW disposal area would be: | • For collocated tritium supply and recycling facilities, solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (42,400 $yd^3$ per year) and the additional LLW disposal area would be: | • For collocated tritium supply and recycling facilities, solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (9,300 $yd^3$ per year) and the additional LLW disposal area would be: | • For collocated tritium supply and recycling facilities, solid LLW generation would increase and require additional onsite LLW disposal area at NTS. The increase over No Action (25 $yd^3$ per year) and the additional LLW shipments to NTS would be: | • For collocated tritium supply and recycling facilities, solid LLW generation would increase for all technologies and require additional onsite LLW disposal area. The increase over No Action (5,100 $yd^3$ per year) and the additional LLW disposal area would be: |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 34 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| HWR: 5,550 $yd^3$ per year - 15 acres per year<br>MHTGR: 1,650 $yd^3$ per year - 4 acres per year<br><br>Large ALWR: 1,060 $yd^3$ per year - 5 acres per year<br><br>Small ALWR: 1,010 $yd^3$ per year - 3 acres per year<br><br>APT: 894 $yd^3$ per year - 3 acres per year<br>For tritium recycling phaseout at SRS, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | HWR: 5,550 $yd^3$ per year - 13.5 acres per year<br>MHTGR: 1,650 $yd^3$ per year - 4 acres per year<br><br>Large ALWR: 1,060 $yd^3$ per year - 4.5 acres per year<br>Small ALWR: 1,010 $yd^3$ per year - 2.5 acres per year<br>APT: 894 $yd^3$ per year - 2.5 acres per year<br>For tritium recycling phaseout at SRS, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | HWR: 5,550 $yd^3$ per year - 3.5 acres per year<br>MHTGR: 1,650 $yd^3$ per year - 1 acre per year<br><br>Large ALWR: 1,060 $yd^3$ per year - 1.2 acres per year<br>Small ALWR: 1,010 $yd^3$ per year - 0.7 acres per year<br>APT: 894 $yd^3$ per year - 0.6 acres per year<br>For tritium recycling phaseout at SRS, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | HWR: 5,550 $yd^3$ per year - 92 shipments per year<br>MHTGR: 1,650 $yd^3$ per year - 27 shipments per year<br>Large ALWR: 1,060 $yd^3$ per year - 32 shipments per year<br>Small ALWR: 1,010 $yd^3$ per year - 18 shipments per year<br>APT: 894 $yd^3$ per year - 16 shipments per year<br>Additional LLW disposal area at NTS would be the same as in NTS alternatives. For tritium recycling phaseout at SRS, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | HWR: 5,200 $yd^3$ per year - 12 acres per year<br>MHTGR: 1,300 $yd^3$ per year - 3 acres per year<br><br>Large ALWR: 710 $yd^3$ per year - 3.5 acres per year<br><br>Small ALWR: 660 $yd^3$ per year - 2 acres per year<br><br>APT: 544 $yd^3$ per year - 1 acre per year |
| • For collocated tritium supply and recycling facilities, small quantity (6 GPY) of liquid mixed LLW from recycling facility would be generated. Existing/planned treatment facilities would be adequate. For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | • For collocated tritium supply and recycling facilities, small quantity (6 GPY) of liquid mixed LLW from recycling facility would be generated. Organic mixed waste treatment capability would be required. For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | • For collocated tritium supply and recycling facilities, small quantity (6 GPY) in liquid mixed LLW generation over No Action (470,000 GPY) would be generated from recycling facility. Existing/planned treatment facilities would be adequate. For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | • For collocated tritium supply and recycling facilities, small quantity (6 GPY) in liquid mixed LLW generation over No Action (402 GPY) would be generated from recycling facility. Existing/planned treatment facilities would be adequate. For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | • For collocated tritium supply and upgraded recycling facilities, no increase in liquid mixed LLW generation from upgraded recycling facility. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 35 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • For collocated tritium supply and recycling facilities, solid mixed LLW generation would increase. The increase over No Action (655 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year<br>HWR may require new or expanded treatment and storage facilities. For tritium recycling phaseout at SRS, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | • For collocated tritium supply and recycling facilities, solid mixed LLW generation would increase. The increase over No Action (5,460 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year<br>Organic mixed waste treatment capability would be required. For tritium recycling phaseout at SRS, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | • For collocated tritium supply and recycling facilities, solid mixed LLW generation would increase. The increase over No Action (11,100 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year<br>Existing/planned treatment facilities would be adequate. For tritium recycling phaseout at SRS, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | • For collocated tritium supply and recycling facilities, solid mixed LLW generation would increase. The increase over No Action (5 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year<br>HWR would require new or expanded treatment and storage facilities. For tritium recycling phaseout at SRS, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | • For collocated tritium supply and recycling facilities, solid mixed LLW generation would increase. The increase over No Action (151 $yd^3$ per year) would be:<br>HWR: 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br>HWR may require new or expanded treatment and storage facilities. Other technologies may require expanded treatment capacity. |
| • For collocated tritium supply and recycling facilities, hazardous waste generation would increase. The increase over No Action (308 $yd^3$ per year) would be:<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year)<br>APT: 4 $yd^3$ per year | • For collocated tritium supply and recycling facilities, hazardous waste generation would increase. The increase over No Action (20 $yd^3$ per year) would be:<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year)<br>APT: 4 $yd^3$ per year | • For collocated tritium supply and recycling facilities, hazardous waste generation would increase. The increase over No Action (1,150 $yd^3$ per year) would be:<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year)<br>APT: 4 $yd^3$ per year | • For collocated tritium supply and recycling facilities, hazardous waste generation would increase. The increase over No Action (63 $yd^3$ per year) would be:<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year)<br>APT: 4 $yd^3$ per year | • For collocated tritium supply and recycling facilities, hazardous waste generation would increase. The increase over No Action (13 $yd^3$ per year) would be:<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year)<br>APT: 3 $yd^3$ per year |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 36 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| Use of existing/planned hazardous waste facilities may be feasible. For tritium recycling phaseout at SRS, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | Additional hazardous waste storage facilities may be required except for APT. APT may require expansion of existing/planned hazardous waste storage facilities. For tritium recycling phaseout at SRS, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | Existing/planned hazardous waste facilities would be adequate. For tritium recycling phaseout at SRS, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | Use of existing/planned hazardous waste facilities would be adequate. For tritium recycling phaseout at SRS, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | Additional hazardous waste storage facilities may be required except for APT. APT may require expansion of existing/planned hazardous waste storage facilities. |
| • For collocated tritium supply and recycling facilities, liquid sanitary waste would be generated and require new treatment facilities. For tritium recycling phaseout at SRS, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For collocated tritium supply and recycling facilities, liquid sanitary waste would be generated and require new treatment facilities. For tritium recycling phaseout at SRS, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For collocated tritium supply and recycling facilities, liquid sanitary waste generation would increase. The increase over No Action (484 MGY) would be:<br>HWR: 2,370 MGY<br>MHTGR: 1,650 MGY<br>Large ALWR: 6,310 MGY<br>Small ALWR: 2,870 MGY<br>APT: 425 MGY<br><br>New treatment facilities would be required. For tritium recycling phaseout at SRS, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For collocated tritium supply and recycling facilities, liquid sanitary waste generation would increase. The increase over No Action (39.9 MGY) would be:<br>HWR: 62.3 MGY<br>MHTGR: 44.3 MGY<br>Large ALWR: 104 MGY<br>Small ALWR: 64.3 MGY<br>APT: 415 MGY<br><br>New treatment facilities would be required. For tritium recycling phaseout at SRS, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For collocated tritium supply and upgraded recycling facilities, liquid sanitary waste generation would increase. The increase over No Action (186 MGY) would be:<br>HWR: 2,350 MGY<br>MHTGR: 1,630 MGY<br>Large ALWR: 6,290 MGY<br>Small ALWR: 2,850 MGY<br>APT: 401 MGY<br><br>New treatment facilities would be required. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 37 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • For collocated tritium supply and recycling facilities, solid sanitary waste generation would increase. The increase over No Action (68,000 $yd^3$ per year) would be:<br><br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year<br>Onsite landfill design life would be reduced or require expansion. For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | • For collocated tritium supply and recycling facilities, solid sanitary waste generation would increase. The increase over No Action (7,000 $yd^3$ per year) would be:<br><br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year<br>Onsite landfill design life would be reduced or require expansion. For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | • For collocated tritium supply and recycling facilities, solid sanitary waste generation would increase. The increase over No Action (77,000 $yd^3$ per year) would be:<br><br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year<br>Onsite landfill design life would be reduced or require expansion. For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | • For collocated tritium supply and recycling facilities, solid sanitary waste generation would increase. The increase over No Action (734 $yd^3$ per year) would be:<br><br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year<br>Offsite (city of Amarillo) landfill design life would be reduced or require expansion. For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | • For collocated tritium supply and upgraded recycling facilities, solid sanitary waste generation would increase. The increase over No Action (80,000 $yd^3$ per year) would be:<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br>Onsite landfill design life would be reduced or require expansion. |
| • For collocated tritium supply and recycling facilities, other solid nonhazardous waste would be recycled. For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | • For collocated tritium supply and recycling facilities, other solid nonhazardous waste would be recycled. For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | • For collocated tritium supply and recycling facilities, other solid nonhazardous waste would be recycled. For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | • For collocated tritium supply and recycling facilities, other solid nonhazardous waste would be recycled. For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | • For collocated tritium supply and recycling facilities, other solid nonhazardous waste would be recycled. No tritium recycling phaseout. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 38 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • For tritium supply alone there would be no change to the impacts for spent nuclear fuel. For tritium recycling upgrade at SRS there would be no change over No Action for spent nuclear fuel. | • For tritium supply alone there would be no change to the impacts for spent nuclear fuel. For tritium recycling upgrade at SRS there would be no change over No Action for spent nuclear fuel. | • For tritium supply alone there would be no change to the impacts for spent nuclear fuel. For tritium recycling upgrade at SRS there would be no change over No Action for spent nuclear fuel. | • For tritium supply alone there would be no change to the impacts for spent nuclear fuel. For tritium recycling upgrade at SRS there would be no change over No Action for spent nuclear fuel. | • No tritium supply alone at SRS. |
| • For tritium supply alone there would be no change to the impacts for liquid LLW. For tritium recycling upgrade at SRS there would be no change over No Action for liquid LLW. | • For tritium supply alone there would be no change to the impacts for liquid LLW. For tritium recycling upgrade at SRS there would be no change over No Action for liquid LLW. | • For tritium supply alone there would be no change to the impacts for liquid LLW. For tritium recycling upgrade at SRS there would be no change over No Action for liquid LLW. | • For tritium supply alone there would be no change to the impacts for liquid LLW. For tritium recycling upgrade at SRS there would be no change over No Action for liquid LLW. | • No tritium supply alone at SRS. |
| • For tritium supply alone solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (5,100 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,200 $yd^3$ per year - 14 acres per year<br>MHTGR: 1,300 $yd^3$ per year -<br>3 acres per year<br>Large ALWR: 710 $yd^3$ per year -4 acres per year<br>Small ALWR: 660 $yd^3$ per year -2 acres per year<br>APT: 544 $yd^3$ per year - 2 acres per year | • For tritium supply alone solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (42,400 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,200 $yd^3$ per year - 12.6 acres per year<br>MHTGR: 1,300 $yd^3$ per year -<br>3 acres per year<br>Large ALWR: 710 $yd^3$ per year -3.8 acres per year<br>Small ALWR: 660 $yd^3$ per year -2 acres per year<br>APT: 544 $yd^3$ per year - 1.5 acres per year | • For tritium supply alone solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (9,300 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,200 $yd^3$ per year - 3.3 acres per year<br>MHTGR: 1,300 $yd^3$ per year -<br>0.8 acres per year<br>Large ALWR: 710 $yd^3$ per year -0.7 acres per year<br>Small ALWR: 660 $yd^3$ per year -0.5 acres per year<br>APT: 544 $yd^3$ per year - 0.4 acres per year | • For tritium supply alone solid LLW generation would increase and require additional onsite LLW disposal area. The increase over No Action (25 $yd^3$ per year) and the additional LLW shipments to NTS would be:<br>HWR: 5,200 $yd^3$ per year - 86 shipments per year<br>MHTGR: 1,300 $yd^3$ per year -<br>22 shipments per year<br>Large ALWR: 710 $yd^3$ per year -26 shipments per year<br>Small ALWR: 660 $yd^3$ per year -13 shipments per year<br>APT: 544 $yd^3$ per year - 10 shipments per year | • No tritium supply alone at SRS. |

TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 39 of 44]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| For tritium recycling upgrade at SRS there would be no change over No Action for solid LLW. | For tritium recycling upgrade at SRS there would be no change over No Action for solid LLW. | For tritium recycling upgrade at SRS there would be no change over No Action for solid LLW. | Additional LLW disposal area at NTS would be the same as in NTS tritium supply alone alternatives. For tritium recycling upgrade at SRS there would be no change over No Action for solid LLW. | No tritium supply alone at SRS. |
| • For tritium supply alone liquid mixed LLW would no longer be generated. For tritium recycling upgrade at SRS there would be no change over No Action for liquid mixed LLW. | • For tritium supply alone liquid mixed LLW would no longer be generated. For tritium recycling upgrade at SRS there would be no change over No Action for liquid mixed LLW. | • For tritium supply alone liquid mixed LLW would no longer be generated. For tritium recycling upgrade at SRS there would be no change over No Action for liquid mixed LLW. | • For tritium supply alone liquid mixed LLW would no longer be generated. For tritium recycling upgrade at SRS there would be no change over No Action for liquid mixed LLW. | • No tritium supply alone at SRS. |
| • For tritium supply alone, solid mixed LLW generation would increase. The increase over No Action (655 $yd^3$ per year) would be:<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid mixed LLW. | • For tritium supply alone, solid mixed LLW generation would increase. The increase over No Action (5,460 $yd^3$ per year) would be:<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid mixed LLW. | • For tritium supply alone, solid mixed LLW generation would increase. The increase over No Action (11,100 $yd^3$ per year) would be:<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid mixed LLW. | • For tritium supply alone, solid mixed LLW generation would increase. The increase over No Action (5 $yd^3$ per year) would be:<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid mixed LLW. | |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 40 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • For tritium supply alone, hazardous waste generation would increase. The increase over No Action (308 $yd^3$ per year) would be:<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for hazardous waste. | • For tritium supply alone, hazardous waste generation would increase. The increase over No Action (20 $yd^3$ per year) would be:<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for hazardous waste. | • For tritium supply alone, hazardous waste generation would increase. The increase over No Action (1,150 $yd^3$ per year) would be:<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for hazardous waste. | • For tritium supply alone, hazardous waste generation would increase. The increase over No Action (63 $yd^3$ per year) would be:<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for hazardous waste. | • No tritium supply alone at SRS. |
| • For tritium supply alone liquid sanitary waste would be generated. Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for liquid sanitary waste. | • For tritium supply alone liquid sanitary waste would be generated. Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for liquid sanitary waste. | • For tritium supply alone, liquid sanitary waste generation would increase. The increase over No Action (484 MGY) would be:<br>HWR: 2,350 MGY<br>MHTGR: 1,630 MGY<br>Large ALWR: 6,290 MGY<br>Small ALWR: 2,850 MGY<br>APT: 401 MGY<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for liquid sanitary waste. | • For tritium supply alone, liquid sanitary waste generation would increase. The increase over No Action (39.9 MGY) would be:<br>HWR: 48 MGY<br>MHTGR: 30 MGY<br>Large ALWR: 90 MGY<br>Small ALWR: 50 MGY<br>APT: 401 MGY<br>Impacts would remain the same as collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for liquid sanitary waste. | • No tritium supply alone SRS. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 41 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • For tritium supply alone solid sanitary waste generation would increase. The increase over No Action (68,000 $yd^3$ per year) would be:<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br>Proportionately decreasing impacts to landfill from collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid sanitary waste. | • For tritium supply alone solid sanitary waste generation would increase. The increase over No Action (7,000 $yd^3$ per year) would be:<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br>Proportionately decreasing impacts to landfill from collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid sanitary waste. | • For tritium supply alone solid sanitary waste generation would increase. The increase over No Action (77,000 $yd^3$ per year) would be:<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br>Proportionately decreasing impacts to landfill from collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid sanitary waste. | • For tritium supply alone solid sanitary waste generation would increase. The increase over No Action (734 $yd^3$ per year) would be:<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br>Proportionately decreasing impacts to landfill from collocated tritium supply and recycling. For tritium recycling upgrade at SRS there would be no change over No Action for solid sanitary waste. | • No tritium supply alone at SRS. |
| • For tritium supply alone other solid nonhazardous waste would be recycled. For tritium recycling upgrade at SRS there would be no change over No Action for other solid nonhazardous waste. | • For tritium supply alone other solid nonhazardous waste would be recycled. For tritium recycling upgrade at SRS there would be no change over No Action for other solid nonhazardous waste. | • For tritium supply alone other solid nonhazardous waste would be recycled. For tritium recycling upgrade at SRS there would be no change over No Action for other solid nonhazardous waste. | • For tritium supply alone other solid nonhazardous waste would be recycled. For tritium recycling upgrade at SRS there would be no change over No Action for other solid nonhazardous waste. | • No tritium supply alone at SRS. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 42 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| • Under No Action negligible tritium transport. | • Under No Action negligible tritium transport. | • Under No Action negligible tritium transport. | • Under No Action the cancer fatalities per year of transporting limited-life components under accident conditions to and from SRS would be $1x10^{-8}$ from radiological affects. | • Under No Action the cancer fatalities per year of transporting limited-life components to/from Pantex is negligible under normal operation. Under accident conditions, the cancer fatalities per year of transporting limited-life components to/from Pantex would be $1.0x10^{-8}$ from radiological affects. |
| | | **Collocated Tritium Supply and Recycling** | | |
| • The relative transportation risk of tritium for collocating supply and recycling is 29 percent lower than the existing No Action case for all technologies. | • The relative transportation risk of tritium for collocating supply and recycling is 30 percent lower than the existing No Action case for all technologies. | • The relative transportation risk of tritium for collocating supply and recycling is 13 percent lower than the existing No Action case for all technologies. | • The relative transportation risk of tritium for collocating supply and recycling is 0. | • The relative transportation risk of tritium supply and upgraded recycling is the same as the existing (No Action) case for all technologies. |
| • The potential cancer fatalities per year for transporting tritiated heavy water for collocated supply and recycling is $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water for collocated supply and recycling is $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water for collocated supply and recycling is $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water for collocated supply and recycling is $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • There is no intersite transport of tritiated heavy water, therefore no transport cancer fatalities. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 43 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • No intersite transport of LLW. | • No intersite transport of LLW. | • No intersite transport of LLW. | • Credible accidents associated with intersite transport of LLW for collocated tritium supply and recycling would result in $5.2 \times 10^{-9}$ to $2.99 \times 10^{-8}$ fatal cancers per year from radiological releases and $6.88 \times 10^{-5}$ to $3.96 \times 10^{-4}$ fatal cancers per year from non radiological causes. The cancer fatalities year for each technology would be:<br><br><u>Radiological</u><br>HWR: $2.99 \times 10^{-8}$<br>MHTGR: $8.79 \times 10^{-9}$<br>Large ALWR: $1.04 \times 10^{-8}$<br>Small ALWR: $5.85 \times 10^{-9}$<br>APT: $5.2 \times 10^{-9}$<br><br><u>Nonradiological</u><br>HWR: $3.96 \times 10^{-4}$<br>MHTGR: $1.16 \times 10^{-4}$<br>Large ALWR: $1.38 \times 10^{-4}$<br>Small ALWR: $7.74 \times 10^{-5}$<br>APT: $6.88 \times 10^{-5}$ | • No intersite transport of LLW. |
| | | **Tritium Supply Alone** | | |
| • The risk of transporting new tritium for a tritium supply alone is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • The risk of transporting new tritium for a tritium supply alone is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • The risk of transporting new tritium for a tritium supply alone is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • The risk of transporting new tritium for a tritium supply alone is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • No tritium supply alone. |

**TABLE 3.6–1.—*Summary Comparison of Environmental Impacts of Tritium Supply and Recycling Alternatives* [Page 44 of 44]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| | | | • Credible accidents associated with intersite transport of LLW for tritium supply alone would result in $3.25 \times 10^{-9}$ to $2.8 \times 10^{-8}$ fatal cancers per year from radiological releases and $4.30 \times 10^{-5}$ to $3.7 \times 10^{-4}$ fatal cancers per year from nonradiological releases. The cancer fatalities per year for each technology would be:<br><br>Radiological<br>HWR: $2.8 \times 10^{-8}$<br>MHTGR: $7.15 \times 10^{-9}$<br>Large ALWR: $8.45 \times 10^{-9}$<br>Small ALWR: $4.22 \times 10^{-9}$<br>APT: $3.25 \times 10^{-9}$<br><br>Nonradiological<br>HWR: $3.7 \times 10^{-4}$<br>MHTGR: $9.46 \times 10^{-5}$<br>Large ALWR: $1.12 \times 10^{-4}$<br>Small ALWR: $5.59 \times 10^{-5}$<br>APT: $4.30 \times 10^{-5}$ | |
| • The potential cancer fatalities per year for transporting tritiated heavy water for tritium supply alone is $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water for tritium supply alone is $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water for tritium supply alone is $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water for tritium supply alone is $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | |

# CHAPTER 4

# Chapter 4

# CHAPTER 4: AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

***Chapter 4 describes the affected environment and the environmental impacts associated with construction and operation of tritium supply and recycling alternatives. The chapter begins with a brief introduction, followed by an overview of applicable environmental assessment methodologies. The affected environment and environmental impacts of tritium supply and recycling facilities are then discussed for each of the following sites: the Idaho National Engineering Laboratory, Nevada Test Site, Oak Ridge Reservation, Pantex Plant, and Savannah River Site. Each discussion begins with a brief site description and overview of the tritium supply technologies and recycling facilities being considered for that site, continues with a description of the affected environment at the site, and concludes with a description of environmental impacts and potential mitigation of each alternative. Following the sections that address individual sites are discussions of potential impacts from tritium supply options, cumulative impacts, commercial light water reactor contingency, and several issues that are common to all sites: intersite transport of tritium; unavoidable adverse environmental impacts; relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; irreversible and irretrievable commitments of resources; facility transition; and environmental justice.***

Discussions of the environment that may be affected at each candidate site, and the associated environmental impacts that would result from the proposed action make up the core of this chapter. In accordance with Council on Environmental Quality (CEQ) regulations (40 CFR 1508.14), the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." The environmental impacts sections provide the analytical basis for the comparisons of potential impacts of the various tritium supply technologies and recycling facilities and No Action that are presented in chapter 3.

**Affected Environment.** The descriptions of the affected environment provide a basis for understanding the direct, indirect, and cumulative effects of the proposed action and alternatives. The localities and characteristics of each potentially affected environmental resource are described for each site. The scope of the discussions varies by resource to ensure that all relevant issues are included.

For land resources, geology and soils, biotic resources, and cultural and paleontological resources, discussions of each Department of Energy (DOE) site and its surroundings are included along with descriptions of the representative area within that site that could be affected by the proposed action. This information provides a basis for understanding both direct effects and the overall resource base that could be affected by ancillary activities that may be defined in later stages of program development.

Ambient conditions are described for air, noise, and water resources. Discussions focus on air and noise conditions at site boundaries and the surface water bodies and groundwater aquifers that could be affected. This information serves as a basis for analyzing key air and water quality parameters to obtain results that can then be compared to regulatory standards.

Socioeconomic conditions are described for the counties and communities that could be affected by regional population changes associated with the proposed tritium supply technologies and recycling facilities. The affected environment discussions include projections of regional growth and related socioeconomic indicators. Each region is large enough to account for growth related to direct project employment as well as secondary jobs that may be induced by the project.

In addition to those natural and human environmental resources discussed above, the affected environment sections include a number of issues related to ongoing DOE activities at each site. These issues

involve facility operations/site infrastructure, intersite transport of tritium, waste management, and radiological and hazardous chemical impacts during normal operation and accidents. Where reasonably foreseeable changes to any of these factors can be predicted, they are discussed.

**Environmental Impacts.** In accordance with CEQ regulations, the environmental consequences discussions provide the analytical detail for comparisons of environmental impacts associated with the various tritium supply technologies and recycling facilities. Discussions are provided for each DOE site and each environmental resource and relevant issues that could be affected.

For comparison purposes, environmental concentrations of emissions and other potential environmental effects are presented with appropriate regulatory standards or guidelines. However, the compliance with regulatory standards is not necessarily an indication of the significance or severity of the environmental impact for *National Environmental Policy Act* (NEPA) purposes.

The purpose of the analysis of environmental consequences is to identify the potential for environmental impacts. The environmental assessment methods used and the factors considered in assessing environmental impacts are discussed in section 4.1, Environmental Resource Methodologies and in the appropriate appendixes. The potential for impacts to a given resource or relevant issue is described in the introduction to each section within the site discussions (sections 4.2 through 4.6) that follow.

## 4.1 Environmental Resource Methodologies

The environmental impact assessment methodologies discussed in this section address the full range of natural and human resource and issue areas pertinent to the sites considered for constructing and operating tritium supply and recycling facilities. These resource areas are: land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. Also included in the discussion are additional issue areas that, although not specifically resources, are important to consider in assessing the environmental effects of the alternative tritium facilities. These issue areas are facilities operation/site infrastructure, intersite transport of tritium, waste management, radiological and hazardous chemical effects during normal operation and accidents, and cumulative effects.

As part of the impact assessment process, each analysis provides mitigation measures that could be used to reduce and minimize potential impacts. Detailed mitigation strategies that might be needed would be addressed in site-specific tiered NEPA documents.

### 4.1.1 Land Resources

This section of the *Tritium Supply and Recycling Programmatic Environmental Impact Statement* (PEIS) considers land use plans and policies, zoning regulations, specially protected lands, and existing land use as appropriate for all sites. In addition, the visual character of each site is described. The potential impacts associated with changes to land use and visual resources as a result of the alternatives are discussed.

**Land Use.** Land use changes associated with the tritium supply technologies and recycling facilities could occur in both rural and urban settings and could affect both developed and undeveloped land. The analysis of land use considers impacts that could result from the modification of existing facilities or the construction of new facilities on or adjacent to each site. Changes in land use are expected to occur within the existing boundaries of most, if not all, DOE sites. However, the use of lands adjacent to or in the vicinity of the DOE sites (i.e., non-DOE land) could be affected by these changes, including new or expanded safety zones.

The degree to which the alternatives affect future use or development of land at each DOE site are considered. Land use impacts are assessed based on the extent and type of land that would be affected. The land use analysis also considers potential direct impacts resulting from the conversion of, or the incompatibility of, land use changes with special status lands such as prime and unique farmlands, and other protected lands such as Federal- and state-controlled lands (e.g., public land administered by the Bureau of Land Management or other government agencies).

**Visual Resources.** Visual resources are defined as natural and human-created features that give a particular landscape its visually aesthetic qualities. Visual resource assessments are conducted to identify and evaluate the impacts on the aesthetics of the landscape from tritium supply technologies and recycling facilities. Visual impacts are assessed based on whether changes in existing facilities or construction of new facilities would appear uncharacteristic in each site's visual setting and, if so, how noticeable those changes would be.

The qualitative visual resource analysis, adapted from the Bureau of Land Management's *Visual Contrast Rating System* (BLM Manual 8431), is conducted to: identify key viewing positions, such as public travel routes, nearby residential/commercial areas, and public uses such as parks, recreation areas, and scenic areas; assess the degree of visibility of new or modified facilities from these key viewing positions; and assess the compatibility of such facilities with the existing physical setting. Classification of the physical settings, existing and modified, for each proposed site was based on the Bureau of Land Management Visual Resource Management (VRM) classes. Class 1 would apply to wilderness areas and similar situations; Class 2 would apply to areas with very limited land development activity resulting in visual contrasts which do not attract attention, such as solitary small buildings or dirt roads; Class 3 would apply to areas where contrasts caused by development activity are evident, but the natural landscape still dominates buildings, utility lines, and secondary roads; Class 4 would apply to areas where contrasts caused by human activities attract attention and are a dominant feature of the landscape, such as a small cluster of two-story buildings, primary roads, and limited clear cutting for utility lines. Class 5 would apply to areas where contrasts caused by cultural activities are the dominant feature of the landscape, such as large industrial/office complexes, landfills, and large expanses of clear cutting or ground disturbance. The analysis provides a qualitative comparison of the characteristics of the existing landscape with those of the proposed facilities and a determination of the resulting level of contrast. Facility characteristics examined include buildings, stacks, access roads, parking areas, facility and perimeter lighting, and steam and emission plumes. Impacts are assessed based on the sensitivity of the affected environment to changes in its visual character. Sensitivity is assessed based on the potential for public concern regarding adverse effects on specific views within the affected environment. More detailed analysis of visual impacts would be conducted in site-specific tiered NEPA documents.

### 4.1.2 Site Infrastructure

Changes to site infrastructure are assessed by overlying the support requirements of the respective tritium supply technologies and recycling facilities upon the projected site infrastructure capacities. These assessments focus upon power requirements, road networks, rail interfaces, and fuel requirements. Projections of electricity availability, site development plans, and other DOE mid- and long-range planning documents are utilized to project site infrastructure conditions. Tables are presented that depict the additional infrastructure requirements to be generated by the alternatives. Mitigation considerations are identified that could reduce impacts due to changes in infrastructure on a site-by-site basis.

Detailed assessments of the tritium facilities' electrical power requirements in the 2010 time frame are not considered practical. Electric utilities would not be expected to reliably project how they would meet the needs of these facilities (i.e., whether by new power generation, power imports, or demand side management). Therefore, the basis for this PEIS assessment is the supply and demand projections of the U.S. electric utilities published annually by the North American Electric Reliability Council.

For purposes of analysis, electricity generation is based on the assumption that electricity would be supplied by the power pool currently supplying the facility in question by using a mix of fuels and generating sources representative of those projected. These data are used to determine whether or not there would be enough reserve margin within a particular power pool to accommodate electrical requirements, or whether additional power is required. A detailed quantitative analysis, based on the proportional contributions from each fuel source, would be conducted in site-specific tiered NEPA documents.

Two of the technologies in question, specifically the Modular High Temperature Gas-Cooled Reactor (MHTGR) and the Advanced Light Water Reactor (ALWR), have the ability to produce electricity from

steam as well as tritium. The environmental effects of this steam production is included in the analysis of the basic technologies since designs of these reactors include steam turbines for electrical production. The environmental impacts of additional power line construction to distribute this electrical production to the grid are not addressed in detail for each site but are discussed in general in section 4.8.1.

The electricity required for the Accelerator Production of Tritium (APT) is assumed to be provided by the power pool which services each site. A separate cost analysis of buying this power versus the option of building a dedicated power plant to provide it is considered in the cost study being prepared to support the Record of Decision (ROD). Therefore, should the APT be selected as the tritium supply source, the selection of the APT could at some point in the tiered NEPA document process include analysis of a dedicated power plant as an electric supply source. For this programmatic level, however, only the general environmental impacts of a dedicated electric power plant are discussed in section 4.8.2.

### 4.1.3 Air Quality and Acoustics

Potential effects on the environment associated with air pollutant emissions and noise from normal operations are evaluated for tritium supply technologies and recycling facilities. The assessment of air quality and acoustic impacts includes identification of applicable criteria for assessing impacts, the development of emission inventories, and the estimation of air pollutant concentrations. The assessment of impacts is based on the estimated concentrations, data on the existing environment, and assessment criteria. Human health effects due to air pollutant emissions are discussed in a separate section and include consideration of airborne radioactive chemical releases.

**Air Quality.** The assessment of potential impacts to air quality is based upon comparison of proposed project effects with applicable state, local, or national ambient air quality standards, or the potential exceedance of prevention of significant deterioration increments for particulate matter of aerodynamic diameter less than 10 micrometers, sulfur dioxide, or nitrogen dioxide.

Assessment criteria for pollutants include the Environmental Protection Agency (EPA) primary and secondary ambient air quality standards for criteria pollutants and those established by each state. The more stringent of either the EPA or state standards serve as the assessment criteria. The assessment criteria for toxic pollutants include guidelines or standards adopted or proposed by each state.

Ambient air monitoring data are used to determine maximum background concentrations of pollutants for each DOE site. Baseline concentrations of pollutants from DOE sites are calculated by modeling site emissions during the baseline year and adding to these calculated concentrations the maximum background concentration for a given pollutant and averaging time. The baseline concentration is a conservative estimate of pollutant concentrations at each DOE site during a period considered representative of recent site activity.

No Action concentrations of pollutants from DOE site emissions are calculated by modeling projected site emissions for the year 2010 and adding to these calculated concentrations the maximum background concentration for a given pollutant and averaging time. Both the baseline and No Action concentrations are compared to applicable Federal and state standards for criteria pollutants and state guidelines and regulations for air toxics to provide an estimate of the potential effects on air quality.

Pollutant concentrations associated with tritium supply technologies and recycling facilities are added to the No Action concentration. These pollutant concentrations are then compared to applicable Federal and state guidelines or standards.

Modeling of site-specific emissions using the EPA-recommended Industrial Source Complex Short-Term Model was performed in accordance with the EPA's *Guideline on Air Quality Models* (EPA-450/2-78-027R). The air quality modeling analysis performed for the candidate sites is a "screening level" analysis incorporating conservative assumptions applied to each of the sites such that the impacts associated with the respective alternatives could be compared among the sites. These conservative assumptions will overestimate the pollutant concentrations at each of the sites.

The assumptions incorporated into the air quality modeling at each site are as follows: major source criteria pollutant emissions were modeled using actual source locations and stack parameters to determine environmental baseline and No Action criteria pollutant concentrations; toxic/hazardous pollutant emissions were modeled from a single source centrally located on each site assuming a ten meter stack height, a stack diameter of one foot, stack exit temperature equal to ambient temperature, and a stack exit velocity equal to 0.01 meters per second.

Emissions from the tritium supply and recycling facilities were located at the tritium supply site (TSS) identified for each site assuming a single stack ten meters in height, a stack diameter of one foot, stack exit temperature equal to ambient temperature, and stack exit velocity equal to 0.01 meters per second. Onsite and/or representative National Weather Service meteorological data is used to define the dispersion characteristics of the site. Actual terrain heights are used for those sites not considered "flat." The potential effects on air quality are described by comparing expected concentrations to air quality standards.

**Acoustics.** Acoustic impacts are assessed on the basis of the potential degree of change in noise levels at sensitive receptors (i.e., residences near the DOE site boundary) with respect to ambient conditions. Most nontraffic noise sources associated with candidate DOE site facilities are located at sufficient distances from offsite noise-sensitive receptors that the contribution to offsite noise levels is expected to be small. Therefore, a qualitative discussion of construction and operation noise sources and the potential for onsite and offsite noise impacts is provided. The analysis uses available information on the potential types of noise sources and the location of proposed alternative facilities relative to the site boundary and noise-sensitive locations. The potential for exposure of workers to noise and the measures taken to protect worker hearing are included. Quantitative analysis of noise impacts is deferred to the site-specific tiered NEPA documents, including noise impacts associated with traffic.

**Uncertainties.** The performance of the Industrial Source Complex Short-Term model has not been validated with field data. However, it is an extended version of a single-stack model (CRSTER) that has been examined using field data from four large power plants. The Industrial Source Complex Short-Term model predicted the upper percentile of the frequency distribution of 1-hour concentrations and of the corresponding distributions of 24-hour concentrations in acceptably good agreement with the measurements. Concentrations over the remainder of the frequency distributions were significantly underpredicted.

The performance of the Industrial Source Complex Short-Term model has been evaluated with field data for its point source submodel (EPA 1977a; EPRI 1983a; EPRI 1985a; EPR 1988a) and for its special features, such as gravitational settling/dry deposition option (EPA 1981a; EPA 1982a) and building downwash option (APCA 1986a; EPA 1981a). The Industrial Source Complex Short-Term model is an extended version of the Single Source (CRSTER) model. From the validation studies for the Single Source (CRSTER) model, based on field data measured at four large power plants, it was concluded that the model acceptably predicts the upper percentile of the frequency distributions of 1-hour concentrations and of the corresponding distributions of 24-hour concentrations. The second-highest 1-hour concentrations were predicted within a factor to two at two-thirds of the field sampling sites for elevated power plant plumes. The second-highest 24-hour concentration to measured concentration ranged from about 0.2 to 2.7 at about 90 percent of the sampling sites (EPA 1977a).

In other validation studies for the point source model, the CRSTER model predicted peak short-term (1-, 3-, and 24-hour) concentration values with 30 to 70 percent at a plain site (EPRI 1983a). The CRSTER model predicted peak 1-hour concentrations within 2 percent and underpredicted peak 3-hour concentrations by about 30 percent at a moderately complex terrain site (EPRI 1985a). The Industrial Source Complex Short-Term model overpredicts 1-hour concentrations by about 60 percent with better predictions for longer time periods at an urban site (EPRI 1988a). Uses of gravitational settling/dry deposition and building downwash options were found to improve the model performance significantly over that of the model without such features (APCA 1986a; EPA 1981a; EPA 1982a).

The concentrations presented in this document are the highest concentrations predicted by the model in

order to present conservative estimates of pollutant concentrations.

### 4.1.4 Water Resources

The quality and quantity of surface water and groundwater resources are described using available data. Potential effects on surface water and groundwater availability and quality are assessed.

**Surface Water.** Local surface water resources in the project region, flow characteristics and relationships, and stream classifications are used to describe current conditions. Data used for impact assessments include rates of water consumption and wastewater discharge for both construction and operation phases. Changes in the annual low flows of surface water resulting from proposed withdrawals and discharges are determined. In cases where low flow data are unavailable, average flow data are used. The existing water supply is evaluated to determine if sufficient quantities are available to support an increased demand by comparing projected increases with the capacity of the supplier and existing water rights, agreements, or allocations.

The water quality of potentially affected receiving waters is determined by reviewing current monitoring data for nonradiological parameters. Potential impacts from radiological parameters are discussed in the radiological and hazardous chemical impacts during normal operation and accidents section. Focus is given to parameters that exceed applicable water quality criteria, as determined by the individual states. Monitoring reports for discharges permitted under the National Pollutant Discharge Elimination System (NPDES) program are examined for compliance with permit limits and requirements. The performance of each candidate DOE site in complying with the permit requirements is presented. In most cases, current design data do not include information on the constituents present or the rate of discharge. The assessment of water quality impacts from wastewater (sanitary and process) and stormwater runoff qualitatively addresses potential impacts to the receiving waters' minimum or average flow, as available and appropriate. Suitable mitigation measures for potential impacts such as stream channel erosion and sedimentation, stream bank flooding, and thermal impacts are identified. Water quality management practices are also reviewed. If effluent constituent data are available, parameters with the potential to further degrade existing receiving water quality along with parameters exceeding existing NPDES permit limits are identified.

Floodplains are identified to determine whether any of the proposed tritium supply technologies and recycling facilities are located within a floodplain. Where possible, the proposed location is compared with the 500-year floodplain. Where these data are unavailable, potential impacts associated with the 500-year floodplain are addressed in terms of design and siting mitigation measures. Specific facility locations will be addressed in site-specific tiered NEPA documents.

**Groundwater.** Groundwater resources are analyzed for effects on aquifers, groundwater usage, and groundwater quality within the regions. Groundwater resources are defined as the aquifers underlying the site and their extensions down the hydraulic gradients to, and including, discharge points and/or the first major users. The affected environment discussion includes a description of the potentially affected groundwater basins. The local aquifers are described in terms of the extent, thicknesses, character of rock formations, and quality of the groundwater. Recharge areas are also noted. Total baseline groundwater use at the facility is compiled using the best available data. Groundwater usage is described and projections of future usage are made based on changing patterns of usage and anticipated growth patterns, whenever site-specific groundwater availability issues are identified.

Drawdown estimates are made both onsite and offsite. Short- and long-term impacts associated with construction withdrawals and dewatering are estimated. Both proposed facilities and existing facilities are considered in determining cumulative impacts.

Available data on existing groundwater quality conditions are compared to Federal and state groundwater quality standards, effluent limitations, and safe drinking water standards. Additionally, Federal and state permitting requirements for groundwater withdrawal and discharge are identified. Impacts of groundwater withdrawals on existing contaminant plumes because of construction and facility operation

are assessed to determine the potential for changes in their rates of migration and the effects of any changes in the plumes on groundwater users. Impacts are assessed by the degree to which groundwater quality, drawdown of groundwater levels, and groundwater availability to other users would be affected. Impacts on groundwater quality are presented when effluent constituent data are available.

### 4.1.5 Geology and Soils

**Geology.** Impacts to the geological environment considers destruction of or damage to unique geological features, subsidence caused by groundwater withdrawal, landslides or shifting caused by loading or removal of supporting rock or soil. The local geology that could affect the alternatives including geomorphology, stratigraphy, structural attitude of rocks, faults and seismicity, general foundation, and boring conditions are described as appropriate for each candidate DOE site. The locations of capable faults are identified and an overview of the seismicity of the site areas, including the history and significance of earthquakes, along with their intensity and ground acceleration, is presented. Areas of potentially unstable slopes and impacts to the stability of slopes by the removal or addition of large volumes of earth in construction are characterized.

**Soils.** Soil types at the proposed project sites are described and the capability of supporting construction of the proposed structures assessed. Shrinking or swelling of ground as a result of landscaping, irrigation, or construction dewatering and soil erosion susceptibility associated with construction is also addressed.

### 4.1.6 Biotic Resources

Potential impacts to biotic resources are addressed for the following categories: terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. During construction, impacts may result from land-clearing activities, erosion and sedimentation, human disturbance and noise, and dewatering of foundations. Operation may affect biotic resources as a result of changes in land use, emission of salt drift (residual salts left behind as a result of the evaporation of cooling tower water) or radionuclides, water withdrawal, wastewater discharge, and human disturbance and noise. In general, the potential impacts are assessed based on the degree to which various habitats or species could be affected by the project. Where appropriate, impacts are evaluated with respect to Federal and state protection regulations and standards.

**Terrestrial Resources.** Potential impacts to terrestrial resources include loss and disturbance of wildlife and wildlife habitats as well as exposure of flora and fauna to emissions of salt drift. Two considerations in assessing the impact of habitat loss are the presence and regional importance of affected habitats, and size of habitat area to be temporarily disturbed by construction activities and permanently disturbed during the operational phase. The loss of important or sensitive habitats is considered more important than the loss of a regionally abundant type. Impacts to wildlife are based to a large extent on plant community loss, which is closely associated with animal habitat. Also evaluated is the disturbance, displacement, or loss of wildlife in accordance with wildlife protection laws such as the *Migratory Bird Treaty Act* and *Bald and Golden Eagle Protection Act*. Cooling tower deposition rates are not calculated; however, potential effects of salt drift are addressed in a qualitative manner.

Very small concentrations of radionuclides would be released to the atmosphere during operation of the proposed tritium supply and recycling facilities. These releases would be well below natural background levels and would also be within regulatory limits established to protect workers and the public. Since humans have been shown to be the most sensitive organism to radiation, these levels should also be protective of biota (AEC 1968a; NAS 1972a). Studies conducted at Idaho National Engineering Laboratory (INEL) have detected sublethal effects in individual animals at contaminated areas; however, no population or community-level impacts resulting from radionuclides have been identified. Monitoring of radionuclide levels outside the boundaries of various INEL facilities and off the INEL site has detected radionuclide concentrations above background levels in individual plants and animals, but the data suggest that the exposed populations are not at risk (DOE 1994i). Thus, based on expected releases and the results of past studies, impacts of radionuclides on site biota were not evaluated.

Impacts to biota from hazardous chemicals during normal operations are unlikely since all hazardous and toxic materials will be handled, stored, transported, and disposed of in accordance with the requirements of the *Resource Conservation and Recovery Act*. Thus, since biota are unlikely to be exposed to hazardous chemicals, impacts were not discussed.

**Wetlands**. Most construction impacts on wetlands are related to displacement of wetlands by filling, draining, or clearing activities. Other impacts could potentially occur from construction activities conducted outside of wetland areas. Operational impacts to wetlands may occur from effluents, surface or groundwater withdrawals, or creation of new wetlands. Wetlands on each DOE candidate site are identified using best available published information such as Federal and state wetland reports, National Wetland Inventory maps, aerial photographs, and topographic maps.

The direct loss of wetlands resulting from construction and operation is addressed in a similar fashion as for terrestrial plant communities, by comparing data on site wetlands to proposed land requirements. Sedimentation impacts are evaluated based on the nearness of wetlands to project areas and with the knowledge that standard construction erosion and sedimentation control measures would be implemented. Impacts resulting from increased flows are evaluated based on a comparison of expected discharge rates with present stream flow rates. Impacts resulting from the introduction of thermal and chemical pollution into a wetland system are evaluated recognizing that effluents will be required to meet Federal and state standards.

**Aquatic Resources.** Aquatic resources could be impacted as a result of sedimentation, increased flows, effluent discharge, impingement, and entrainment. Impacts to aquatic resources, such as loss of spawning habitat resulting from sedimentation, increased flows, and the introduction of waste heat and chemicals, are evaluated as described for wetlands.

Impingement and entrainment impacts are evaluated based on a comparison of stream flow and intake volumes, recognizing that when intake volumes represent a large percentage of stream flow, the possibility of impingement and entrainment impacts exists. Compliance with protective measures, such as the *Anadromous Fish Protection Act*, are addressed.

Although aquatic species could be exposed to radionuclides from cooling tower blowdown at wet sites, previous studies of a proposed tritium reactor at the Savannah River Site (SRS) that was larger than the proposed current design have shown that calculated doses were well below limits established by DOE Order 5400.5, *Radiation Protection of the Public and the Environment* for the protection of aquatic organisms (DOE 1992e). Although impacts to aquatic life are unlikely based on the conservative nature of the calculations and the size difference between the previous and current reactor designs, further assessments may be required in site-specific NEPA documentation.

**Threatened and Endangered Species.** Impacts to threatened and endangered species of wildlife and plants, including critical habitat, state-listed species, and species proposed for listing, are determined. A list of species potentially present on each site is developed using information obtained from the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and appropriate state agencies. This list, along with site environmental and engineering data, is used to evaluate whether the various tritium supply technologies and recycling facilities would impact any plant or animal (or its habitat). Impacts are determined in a manner similar to that described for terrestrial and aquatic resources since the sources of potential impacts are similar.

**Uncertainties.** Due to the programmatic nature of this PEIS, a number of factors which may impact biotic resources are not known with certainty. These include site location, placement and performance of wet cooling towers, routing of rights-of-way, and wastewater discharge characteristics and location. Each of these factors introduced uncertainties in the analysis of impacts to biotic resources. For example, not knowing the exact location of the TSS prevents an exact analysis of impacts on terrestrial habitat and wetlands, as well as threatened and endangered species. Since more information will be available as PEIS project planning progresses, analyses presented in tiered NEPA documentation at a selected site will not be so limited by uncertainties.

### 4.1.7 Cultural and Paleontological Resources

Included in these sections are evaluations of the impacts of the tritium supply technologies and recycling facilities on prehistoric, historic, Native American, and paleontological resources. The effects considered include those resulting directly from land disturbance during construction, visual intrusion to the settings or environmental context of historic structures, visual and audio intrusions on Native American sacred sites, reduced access to Native American traditional use areas, unauthorized artifact collecting, and vandalism.

**Prehistoric Resources.** Prehistoric resources are physical properties resulting from human activities that predate written records. They are generally identified as either isolated artifacts or sites. Sites may contain concentrations of artifacts (e.g., stone tools and ceramic shards), features (e.g., campfires and houses), and plant and animal remains. Depending on their age, complexity, integrity, and relationship to one another, sites may be important for and capable of yielding information about past populations and adaptive strategies. The affected environment section for prehistoric resources includes a brief overview of the number and types of prehistoric sites in the project areas, if known, and their status on both the National Register of Historic Places (NRHP) and appropriate state registers. The overview consists of a summary of existing information about prehistoric resources in the region and a discussion of types of sites that are likely to occur.

Impact assessments for prehistoric resources focus mainly on those properties likely to be eligible for the NRHP. Impacts are assessed by considering whether the proposed action could substantially add to existing disturbance of resources in the project areas, adversely affect NRHP-eligible resources, or cause loss of or destruction to important prehistoric resources.

**Historic Resources.** Historic resources consist of physical properties that postdate the existence of written records. Historic resources include architectural structures (e.g., buildings, dams, and bridges) and archaeological features (e.g., foundations, trails, and trash dumps). Ordinarily, sites less than 50 years old are not considered historic for analytical purposes, but exceptions can be made for younger properties if they are of exceptional importance; i.e., structures associated with World War II, the Manhattan Project, or Cold War themes (36 CFR 60.4). The affected environment section for historic resources includes a brief overview, the number and types of historic sites in the project areas, if known, and their status on both the NRHP and appropriate state registers. The overview consists of a summary of existing information about historic resources in the region and a discussion of the types of sites that likely exist.

Impact assessments for historic resources focus mainly on those properties likely to be eligible for the NRHP. Impacts are assessed by considering whether the proposed action could substantially add to existing disturbance of resources in the project areas, could adversely affect NRHP-eligible resources, or could cause loss of or destruction to important historic resources.

**Native American Resources.** Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. Of primary concern are concepts of sacred space that create the potential for land use conflicts. Native American concerns would be identified through direct consultation with tribal representatives and field visits with tribal religious specialists during site-specific tiered NEPA documents. Contacts will be identified by reference to the ethnographic literature, by state and national pantribal organizations, and by agency and academic professionals in anthropology.

The individual resource type, the proximity of impact areas to the resources, and the likely duration of impacts are considered in the analysis of Native American resources. Specific concerns include the relative importance of the resource in the Native American physical universe or belief system; the distance at which activities in the vicinity of a sacred area constitute a disturbance; the extent to which affected resources may be restored; and the extent to which alternative sources for raw materials are available and/or suitable. Impacts to Native American resources are assessed by considering whether the proposed action has the potential to affect sites important for their position in the Native American physical universe or belief system, or the possibility of reducing access to traditional use areas or sacred sites.

**Paleontological Resources.** Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. They include casts, molds, and trace fossils such as burrows or tracks. Fossil localities typically include surface outcrops, areas where subsurface deposits are exposed by ground disturbance, and special environments favoring preservation, such as caves, peat bogs, and tar pits. Paleontological resources are important mainly for their potential to provide scientific information on paleoenvironments and the evolutionary history of plants and animals. The affected environment section for paleontological resources includes a description of known paleontological localities and geological formations in the project areas that may be fossil bearing.

Impact assessments for paleontological resources are based on the numbers and kinds of resources that could be affected as well as the quality of fossil preservation in a given deposit, particularly in deposits with high research potential. Such deposits include poorly known fossil forms; well-preserved terrestrial vertebrates; unusual depositional contexts; assemblages containing a variety of fossil forms, particularly associations of vertebrates, invertebrates, and plants; or deposits recovered from poorly studied regions or in unusual concentrations.

### 4.1.8 Socioeconomics

These sections describe and assess impacts on local and regional socioeconomic conditions and factors including population, employment, economy, housing, public finance, and transportation. This PEIS assesses the socioeconomic impacts of both the gains and losses of missions at each site. Geographically, the potential for socioeconomic effects is greatest in those local jurisdictions immediately adjacent to each site and those that are the residential locations of the majority of DOE site employees. A region-of-influence (ROI), comprised of those local jurisdictions likely to experience the greatest socioeconomic impacts, is defined for each DOE site. The ROI is defined as those areas where approximately 90 percent of the current DOE and contractor employees reside. The evaluation of impacts is based on the degree to which changes in employment and population affect the local economy, housing market, public finance, and transportation. The changes to these factors are projected to the year 2030 because it is assumed that after 2030 the impacts associated with the alternatives are negligibly different from the 2030 conditions. The following sections discuss each of the socioeconomic conditions and factors considered.

**Employment.** The construction and operation of tritium supply technologies and recycling facilities could affect employment at DOE sites. Changes in site employment would, in turn, directly affect local and regional populations, economies, housing, public finance, and transportation. Current employment at each DOE site is described as well as projected employment associated with other planned DOE initiatives. Socioeconomic trends and the relationship of site employment to these trends are examined for each potentially affected socioeconomic region. Emphasis is placed on evaluating total direct and indirect employment changes and impacts associated with potential mission relocations.

**Economy.** The regional economies surrounding each DOE site are characterized. Emphasis is placed on the measurement of the relative contribution and importance of each site's employment payroll and purchases to the economy. Changes to local economic conditions are evaluated based on each site's relative contribution and changes to employment. Emphasis is placed on the economic effects of mission changes associated with the tritium supply technologies and recycling facilities.

**Population.** The demographic changes in the regions surrounding each site are described and assessed. Demographic characteristics are presented for the site's ROI to support the assessment of socioeconomic impacts. Trends are identified and used to project demographic changes over the environmental baseline period. Cumulative population impacts include the population impacts of other DOE actions under consideration, including planned environmental restoration activities.

**Housing.** Changes in employment at each DOE site would affect the demand and supply of housing units, including the need for temporary housing (e.g., rental units) to support in-migrating construction workers. Trends in the housing availability within each site's socioeconomic ROI are characterized and evaluated. Numbers of in-migrating and out-migrating site employees associated with each of the tritium facility

alternatives are then used to evaluate housing impacts.

**Public Finance.** Each DOE site is located on land owned by the Federal government; this exempts these lands from state and local taxation. However, all employee income, property, and purchases are subject to applicable state and local taxation requirements.

Changes in community finances as a result of the alternatives could affect the community's need and ability to provide community infrastructure and services that include utility, water, and sewage facilities, as well as education, health care, and police and fire protection. The fiscal impacts of the alternatives on the counties, cities, and school districts within the site's ROI are assessed.

**Local Transportation.** The transportation systems in the region surrounding each DOE site, including roads and highways, rail systems, and airports, are characterized. Major planned improvements to regional transportation systems are identified as part of the environmental baseline characterization. Changes in site employment associated with the alternatives are used to identify potential impacts to the existing traffic conditions at each site.

### 4.1.9 Radiation and Hazardous Chemical Environment

Nuclear facilities use a broad variety of processes involving both radioactive and chemical materials that can be hazardous to people who may be exposed to them. The degree of hazard is directly related to the type and quantity of the particular radioactive or chemical material to which the person may be exposed. The health effects are determined for tritium supply and recycling facilities by identifying the types and quantities of material to which one is exposed, estimating doses, and then calculating the resultant health effects.

The impacts on human health for workers and the public during normal operation and postulated accidents from the various alternatives are assessed. Models are used to project the impacts on the health of workers and the public due to normal operation and postulated accidents. These models include: GENII and Melcor Accident Consequence Code System (MACCS) for airborne and liquid radioactive releases; CHEM-PLUS for fire and explosions; and SLAB for hazardous chemical releases. Atmospheric dispersion modeling performed for the air quality section is also utilized in the evaluation of impacts to workers from radiological and hazardous chemicals.

**Health Impacts on Plant Workers During Normal Operation.** Because radiation workers are individually monitored, experience from past and current operation that are similar to future operation are used to estimate the radiological health impacts to workers. Health impacts from chemicals are discussed qualitatively. Since for chemicals there are no individual exposure data on workers, models are used to estimate the worker chemical exposure dose.

**General Health Impacts on the Public During Normal Operation.** Public health impacts could result from exposure to radioactive or hazardous chemical materials released during operation. The effect is the sum of internal exposure resulting from breathing air, eating food, and drinking water, and of external exposure from standing on contaminated ground, being exposed to the air, and submerged in water.

Modeling is used to estimate the type and amount of material released and the associated radiological and chemical doses. These doses are converted to health effects using appropriate health risk estimators.

**Epidemiological Studies.** In March 1990, the Secretary of Energy announced that DOE would turn over responsibility for analytical epidemiologic research on long-term health effects on workers at DOE facilities and the public in surrounding communities to the Department of Health and Human Services, and directed that worker and public health and exposure data be released. A Memorandum of Agreement with the Department of Health and Human Services was signed in January 1991. The Department of Health and Human Services is now conducting the ongoing health effects research program.

**Accident Analysis for Postulated Accident Scenarios.** The relative consequences of postulated accidents in the evaluation of each alternative are considered. In evaluating the magnitude and consequences of each alternative, a suitable accident

analysis is performed to produce results for decision-making purposes. Although the concepts used are analogous to a formal Probabilistic Risk Assessment, which would be appropriate for a project-level analysis, the accident analysis involves considerably less detail and only addresses a representative spectrum of beyond design basis accidents (high consequence, low probability) and a representative spectrum of possible operational accidents (low consequence but high probability of occurrence). The technical approach for the selection of accidents is consistent with the DOE Office of NEPA Oversight *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* guidance which recommends consideration of two major categories of accidents: within design basis accidents and beyond design basis accidents.

For the purpose of this assessment, risk is defined as the mathematical product of the probability and consequences of an accident. The risk-contributing scenarios consider both design-basis and severe accidents. The specific accidents consider the types of facilities. Examples of accidents include those resulting from operator errors, spills, criticality, fire, explosions, airplane crash, common-cause failures, collocated facilities, severe weather, earthquakes, and transportation. Information on potential accidents includes those that have been postulated and analyzed for similar facilities. The risks of the various tritium supply technologies and recycling facilities are evaluated in terms of the incremental increase in risk and the cumulative effect of that risk with respect to normal day-to-day risks to which the general population is exposed.

Accident risk to workers was not calculated because of the conceptual design of the tritium supply technologies, and the lack of a specific location within a candidate site for such a facility. However, worker risk is included in the estimated risk to the population within 50 miles. Risk to workers from radiological accidents would be addressed in site specific tiered NEPA documents when more detailed information is available.

**Uncertainties.** The sequence of analyses performed to generate the radiological impact estimates from normal operation and facility accidents include: (1) selection of accident sequence, (2) estimation of source terms, (3) estimation of environmental transport and uptake of radionuclides, (4) calculation of radiation doses to exposed individuals, and (5) estimation of health effects. There are uncertainties associated with each of these steps. Uncertainties exist in the way the physical systems being analyzed are represented by the computational models and in the data required to exercise the models (due to measurement errors, sampling errors, or natural variability).

In principle, one can estimate the uncertainty associated with each source and predict the remaining uncertainty in the results of each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final results. However, conducting such a full-scale quantitative uncertainty analysis is neither practical nor a standard practice for a study of this type. Instead, the analysis is designed to ensure—through judicious selection of release scenarios, models, and parameters—that the results represent the potential risks. This is accomplished by making conservative assumptions in the calculations at each step. The models, parameters, and release scenarios used in the calculations are selected in such a way that most intermediate results and consequently, the final estimates of impacts are greater than what would be expected. As a result, even though the range of uncertainty in a quantity might be large, the value calculated for the quantity is close to one of the extremes in the range of possible values, so that the chance of the actual quantity being greater than the calculated value is low (or the chance of the quantity being less than the calculated value if the criteria are such that the quantity has to be maximized). This has been the goal of the radiological assessment for normal operation and facility accidents in this study (i.e., to produce results that are conservative).

The degree of conservatism in the calculated results is closely related to the range of possible values the quantity can have. This range is determined by what can be expected to realistically occur. Thus, the only processes, events, and accidents considered are those credible for the conditions under which the physical system being modeled operates. This consideration has also been employed for both normal operation and facility accident analyses.

Uncertainties are also derived from the lack of engineering design data for facilities that are only conceptual. Uncertainties are also introduced when accident analyses performed for similar existing facilities have been used as a major source of data. Although the radionuclide composition of source terms are reasonable estimates, there are uncertainties in the radionuclide inventory and release reactions which affect the estimated consequences. Accident frequencies for low probability sequences of events are always difficult to estimate, even for operating facilities, because there is little or no record of historical occurrences. For a new facility, such as the Heavy Water Reactor (HWR), MHTGR, ALWR, and APT any use of accident frequencies that are estimated from similar existing facilities would tend to further compound the effects of uncertainties.

There are also uncertainties attributed to differences in information sources. For the HWR and MHTGR a considerable amount of information on source terms and accident scenarios is based on 1992 documentation for the New Production Reactor program. For the ALWR, there are four technologies with documentation and analyses prepared independently by different vendors. For the APT, there are two technologies with documentation and analyses prepared by a team led by Sandia National Laboratories, New Mexico, Los Alamos National Laboratory, Brookhaven Laboratory, and private contractors.

The risk analysis presented in this PEIS is not a complete risk assessment in the sense of identifying and analyzing all physically possible accidents including those high consequence accidents whose probability is so remote as to render them not reasonably foreseeable. The accident analyses do include, however, the full spectrum of reasonably foreseeable accidents including high consequence accidents and their associated risks for the technologies and facilities. These severe accidents have low accident frequencies, often less than $1.0 \times 10^{-6}$ per year. The accident analyses also include higher frequency accidents (design basis and other operational accidents) that typically have lower consequences. These design basis and other operational accidents have accident frequencies that are greater than $1.0 \times 10^{-6}$ per year.

In summary, the radiological and hazardous chemical impact estimates presented in this document were obtained by

- Using the best available data.
- Using state-of-the-art computational tools.
- Considering the processes, events, and accidents that are reasonably foreseeable for the tritium supply and recycling facilities described in this study and the environment.
- Making conservative assumptions when there is doubt about the exact nature of the processes and events taking place.

### 4.1.10 Waste Management

A major thrust of the overall reconfiguration program effort has been, and will continue to be, the minimization of wastes. The proposed action would consider and incorporate waste minimization and pollution prevention practices. Alternative processes and technologies used in the production and recycling of tritium are being reviewed to determine whether proven technologies could accomplish significant reductions in the generation of waste. An assessment of the ability to minimize waste generation through greater standardization of nuclear weapons designs is also performed. This would minimize the need for specialty processes that create unique waste treatment and disposition problems. Waste minimization efforts and the management of tritium-related wastes are discussed for each DOE site. Tritium facilities would treat and package waste into forms that would enable long-term storage or disposal. Pantex is the only site under consideration that does not have existing onsite low-level waste (LLW) disposal; the number of additional shipments required to transport LLW from Pantex to a DOE LLW disposal facility is estimated. The risks associated with additional shipments are addressed as part of the intersite transport assessment. Long-term disposition of wastes and other methods of waste minimization is expected to be addressed by the DOE Office of the Assistant Secretary for Environmental Management (EM) as part of an overall waste management strategy. The PEIS prepared by EM will

evaluate the environmental impacts of transporting wastes. Both this document and the PEIS prepared by EM are intended to provide environmental input into development of long-term strategies that, when decided on, provide a basis for assessing and implementing site-specific and facility-specific actions.

The construction and operation of tritium facilities could generate spent nuclear fuel and several types of wastes. Generation points are different dependent upon siting of various facilities. Construction wastes are similar to those generated by any construction project of comparable scale. Wastes generated during the operation of tritium supply and recycling facilities consist of four primary types: low-level radioactive waste, low-level mixed waste, hazardous waste, and nonhazardous waste. The types and amounts of waste and spent nuclear fuel vary according to the tritium supply technology.

The nuclear weapons mission provides for the short-term management and onsite storage of wastes and spent nuclear fuel, including the means to minimize waste generation, until DOE either disposes of the wastes or places them in long-term storage. To provide a framework for addressing the impacts of waste management for tritium supply technologies and recycling facilities, descriptive information is presented on waste management activities anticipated for each DOE site and tritium facility combination. The volumes of each waste type generated are estimated by facility and DOE site for tritium supply technologies and recycling facilities and vary according to technologies analyzed for the facilities. These estimates include consideration of concepts for waste minimization. The impact assessment addresses the waste types and waste volumes projected to be generated from the various tritium supply technologies and recycling facilities at each site versus No Action. Impacts are assessed in the context of site practices for treatment, storage, and disposal plus the applicable regulatory setting of the *Atomic Energy Act; Federal Facility Compliance Act; Resource Conservation and Recovery Act* (RCRA); *Clean Air Act* (CAA); *Clean Water Act* (CWA); *Toxic Substances Control Act* (TSCA); *Safe Drinking Water Act* (SDWA); *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA); NEPA; and DOE orders.

The volumes of wastes to be generated by tritium supply technologies and recycling facilities were provided for inclusion, consideration, and evaluation of alternative waste management configurations in the PEIS being prepared by EM. The evaluation of waste management for tritium supply and recycling facility-generated waste are presented in both documents.

D&D activities are greatly dependent upon the final disposition of a facility and its design. D&D could range from performing a simple radiological survey to completely dismantling and removing a radioactively-contaminated facility. Because the tritium supply technology and recycling facility designs are preconceptual, estimates of D&D waste volumes have not been made; however, a relative comparison between the tritium supply technologies was made.

### 4.1.11 Intersite Transportation

The intersite transport assessment addresses the transport of tritium since this material is the primary focus of this PEIS. A transportation baseline, using historical and projected shipment information, is established for evaluating potential environmental impacts. The existing transportation modes that serve each DOE site and the transportation links to those modes for the intersite transport of hazardous materials are described. The packaging required for the shipment of tritium is described. Risks are calculated for transporting LLW generated from tritium activities.

The potential environmental impacts of transporting tritium are qualitatively determined using existing health and accident risk data. Quantitative data are included, as appropriate. For evaluating the risk, the following elements are considered: transport mode, weight of material, curies, proximity dose rates (transport index), type of package, number of shipments, and distance. Health impacts are presented for the transportation of tritium associated with tritium operations for normal (incident-free) transportation and accident conditions.

### 4.1.12 Cumulative Impacts

Cumulative impacts address the incremental effects of the action when added to other past, present, and reasonably foreseeable future actions regardless of

what agency (Federal or non-Federal) or person undertakes such other actions (43 FR 55978; 40 CFR 1500-1508).

Other DOE programs (including environmental management missions) and other Federal, state, and local development programs all have the potential to contribute to cumulative effects on DOE sites. "Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). To the extent information was available for these other actions at a given site, the cumulative impacts are presented.

**Continuing Department of Energy Missions.** Continuing DOE missions and any reasonably foreseeable changes to these missions are addressed as part of the affected environment baseline. Continuing missions at each site are discussed in the Site Infrastructure section of the affected environment discussion for each DOE site. These missions provide the baseline against which the tritium supply technologies and recycling facilities are compared. For example, water requirements for the tritium supply technologies and recycling facilities are combined with requirements of continuing missions to assess the total impact to water resources.

**Environmental Management Missions.** Any planned and reasonably foreseeable new or modified waste handling facilities are discussed in the waste management section for each site. In addition, to the extent that other environmental management missions or strategies are planned and defined, they are also discussed as are bounding environmental impacts of waste management actions. Specific waste management activities will be addressed in the PEIS being prepared by EM.

**Other Federal and State Programs.** Other Federal and state programs are identified but only planned, reasonably foreseeable programs are considered. Typical programs in this category include public works projects and military base closures and reuse projects. Potential consequences of any major programs that accumulate effects when combined with the tritium supply and recycling alternatives are presented.

**Local Development Programs.** Local development programs are not specifically identified. However, socioeconomic projections take into account anticipated regional growth. Local development programs are a part of this growth and are addressed collectively using growth as a surrogate. Socioeconomic projections form the baseline for much of the environmental analysis presented in this document.

**Approach for Cumulative Impact Assessments.** There is no generic methodology for the assessment of cumulative impacts. Therefore, the following approach represents a design for analyzing programmatic cumulative impacts relative to past, present, and probable future activities. It incorporates a wide ranging view of DOE defense programs, environmental management, and other outside interactions. This strategy is integrated with detailed resource-specific assessment methods where appropriate, and can be developed further in tiered project-specific NEPA documentation to ensure compatibility across defense programs, environmental management, and other programs.

The rationale for this approach reflects that this PEIS is a programmatic document. The reference condition for cumulative effects is the No Action alternative. The strategy has four major components:

- Focus analysis primarily on the impacts at each tritium supply candidate site where other defense programs and/or environmental management activities are reasonably anticipated. Past, baseline, and future defense programs and environmental management activities are more clearly defined and have a higher degree of certainty than offsite activities. These activities tend to be much more speculative the further into the future they are planned.

- Address quantitatively cumulative impact analyses associated with offsite activities in tiered, site-specific NEPA documentation.

- Coordinate efforts between defense programs and environmental management activities through the Memorandum of Agreement between defense programs and environmental management activities.

- Focus on site-specific cumulative effects from tritium supply and recycling, addressing them in terms of both the temporal and spatial aspects of defense programs activities, as well as, the level, phasing, and site-specific locations of proposed environmental management facilities and activities. This is appropriate due to the uncertainty and lack of specificity associated with offsite activities that could result in significant incremental, indirect, or synergistic cumulative impacts; these activities are more effectively addressed in tiered site-specific NEPA documentation.

The method is flexible and allows for the assessment of cumulative impacts to regulated resources at a lower level of analysis due to the protection afforded to them through applicable regulations. In addition, the method recognizes that the focus on a given resource may vary according to site-specific characteristics of the local environment. Where these type of variations are identified, a level of analysis would be performed commensurate to the importance of the potential cumulative impacts on that resource.

## 4.2 IDAHO NATIONAL ENGINEERING LABORATORY

The Idaho National Engineering Laboratory (INEL) was established in 1949, and currently occupies approximately 570,000 acres near Idaho Falls, ID. As discussed in section 3.3.2, INEL performs research and development activities on reactor performance; conducts materials testing and environmental monitoring activities; performs research and development activities for the processing of waste; conducts breeder reactor development; and is a naval reactor training site. There are currently no DOE defense program missions at INEL. The DOE property boundaries for INEL are illustrated in figure 4.2–1.

### 4.2.1 Description of Alternatives

Under the proposed action, any one of the four tritium supply technologies (Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), Advanced Light Water Reactor (ALWR), or Accelerator Production of Tritium (APT)) alone or collocated with a new tritium recycling facility could be sited at INEL. Section 3.4.2 provides a description of the tritium supply technologies and section 3.4.3.1 describes the tritium recycling facility. Figure 4.2.1–1 shows the location of existing facilities within INEL and the tritium supply site (TSS).

Under No Action, INEL would continue to perform the missions described in section 3.3.2. There are no facilities at INEL that would be phased out as a result of any of the proposed action alternatives discussed in this PEIS.

### 4.2.2 Affected Environment

The following sections describe the affected environment at INEL for land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure at INEL, the radiation and hazardous chemical environment, and the waste management conditions are described.

#### 4.2.2.1 *Land Resources*

The discussion of land resources at INEL includes land use and visual resources.

**Land Use.** INEL is located within Bingham, Bonneville, Butte, Clark, and Jefferson Counties, 22 miles west of downtown Idaho Falls in southeastern Idaho. The site covers approximately 570,000 acres, all of which is owned by the Federal government and is administered, managed, and controlled by DOE. The Federal government also owns approximately 75 percent of the land bordering INEL; this land is administered by the Bureau of Land Management. Twenty-four percent of adjacent land is privately owned, with the remaining 1 percent held by the State of Idaho. Generalized land uses at INEL and in the vicinity are shown in figure 4.2.2.1–1. Only 2 percent of the land within INEL has been developed for the nine operating areas and facilities. The developed INEL facilities are sited within a central core area of 225,000 acres designated as open space.

A buffer zone consisting of 345,000 acres surrounding the central core area has been created within INEL boundaries. The Bureau of Land Management has entered into a Memorandum of Understanding with DOE to permit private individuals to graze livestock on the buffer zone rangeland. However, the grazing of livestock is prohibited within the central core area and within 2 miles of any nuclear facilities. Other agricultural activities consist of approximately 140 acres of irrigated cropland located adjacent to State Routes 28 and 33, and just west of the Mud Lake community. No prime farmland lies within the INEL boundaries.

In 1975, DOE designated most of INEL as a National Environmental Research Park. It is used by the national scientific community as an outdoor laboratory for environmental sciences research on changes to the natural environment caused by human activities.

The proposed 600-acre TSS would be located within INEL's Prime Development Land Zone. This designation applies to land most suitable for development due to an absence of physical constraints such as steep slopes, faults, and floodplains, and because of the land's proximity to site infrastructure such as roads, utilities, and INEL support facilities.

Offsite land use within 2 miles of INEL is shown in figure 4.2.2.1–1. This offsite land is primarily used for livestock and agricultural purposes. The closest

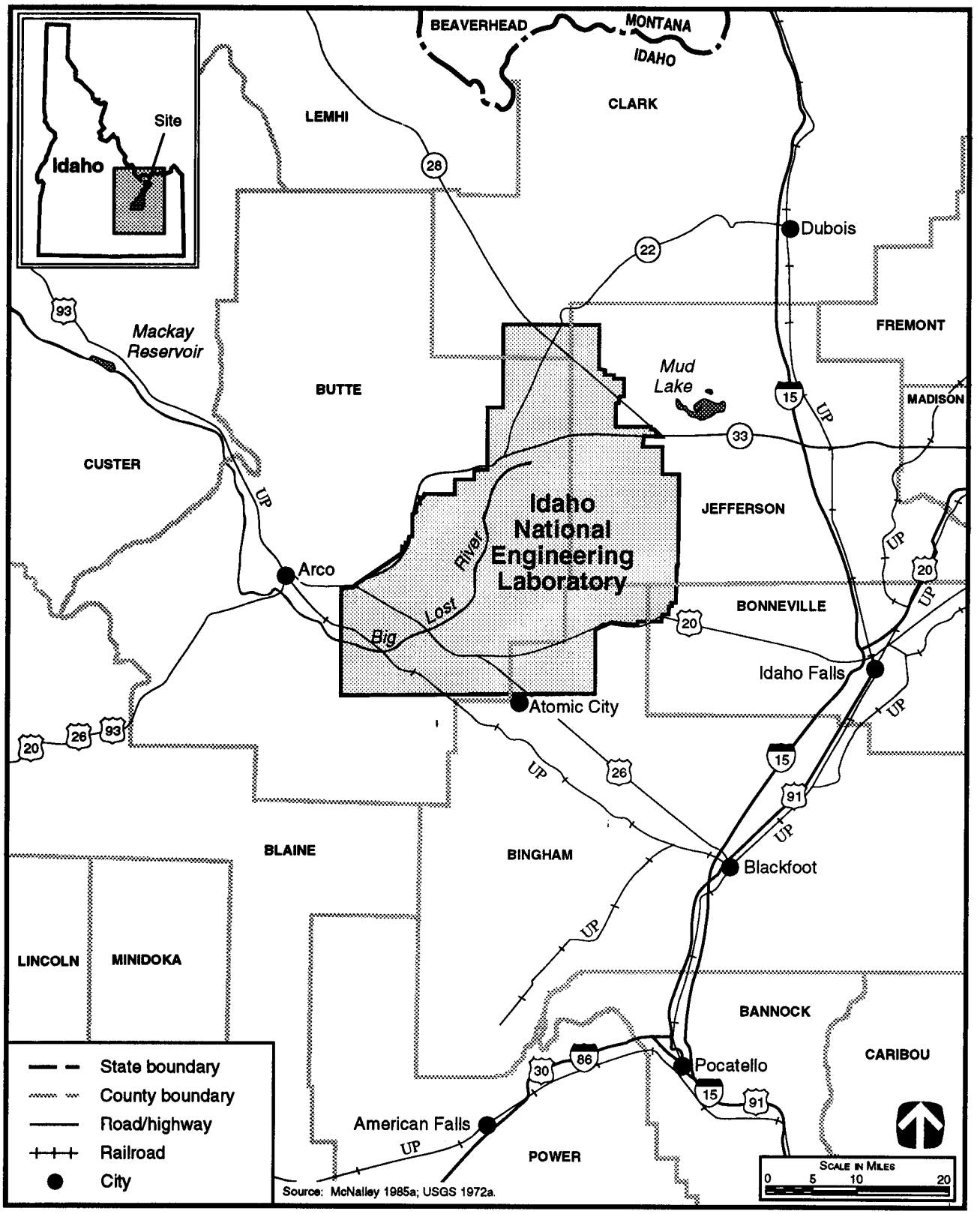


**FIGURE 4.2–1.**—***Idaho National Engineering Laboratory, Idaho, and Region.***

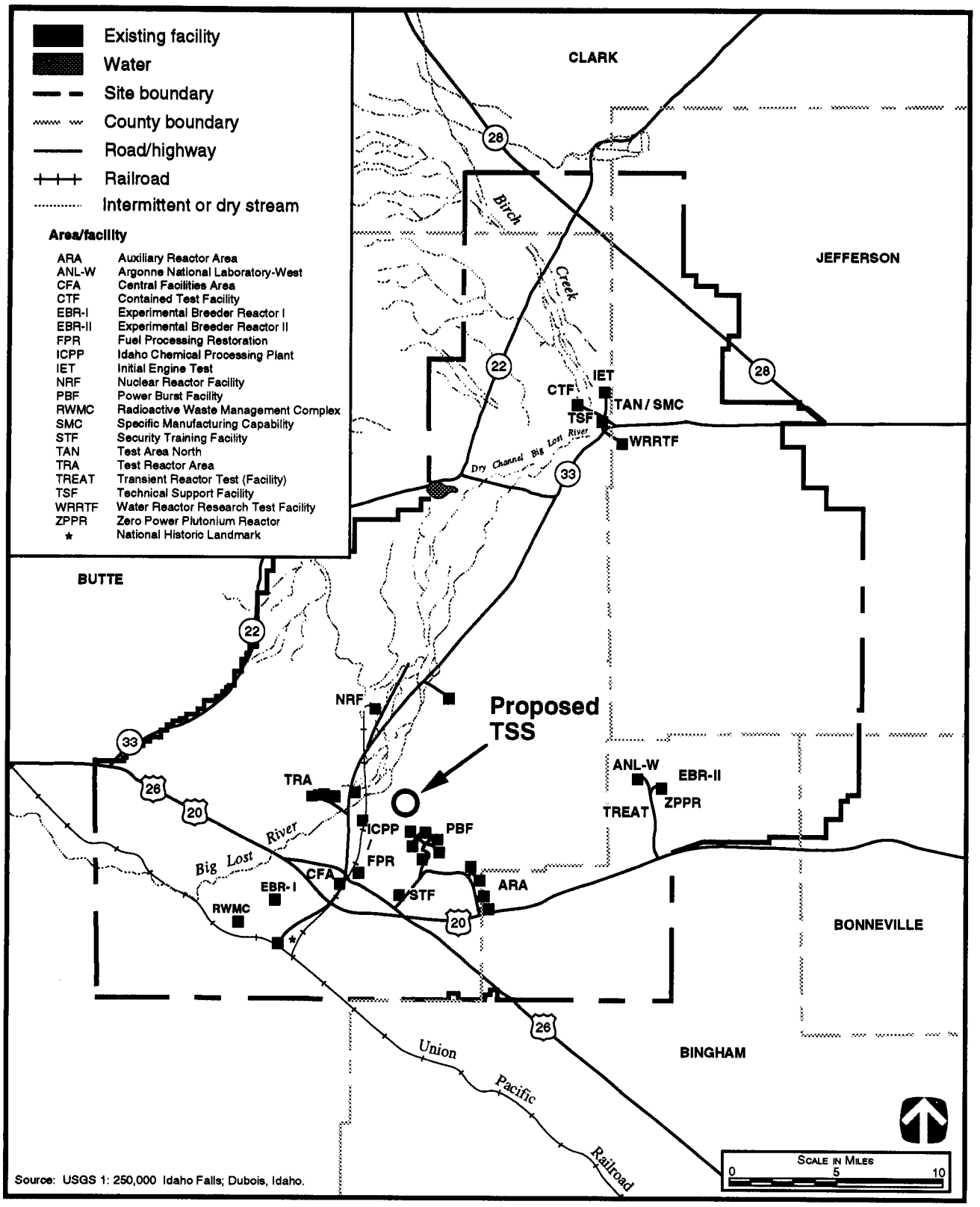


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**FIGURE 4.2.1–1.**—*Primary Facilities and Proposed Tritium Supply Site at Idaho National Engineering Laboratory.*

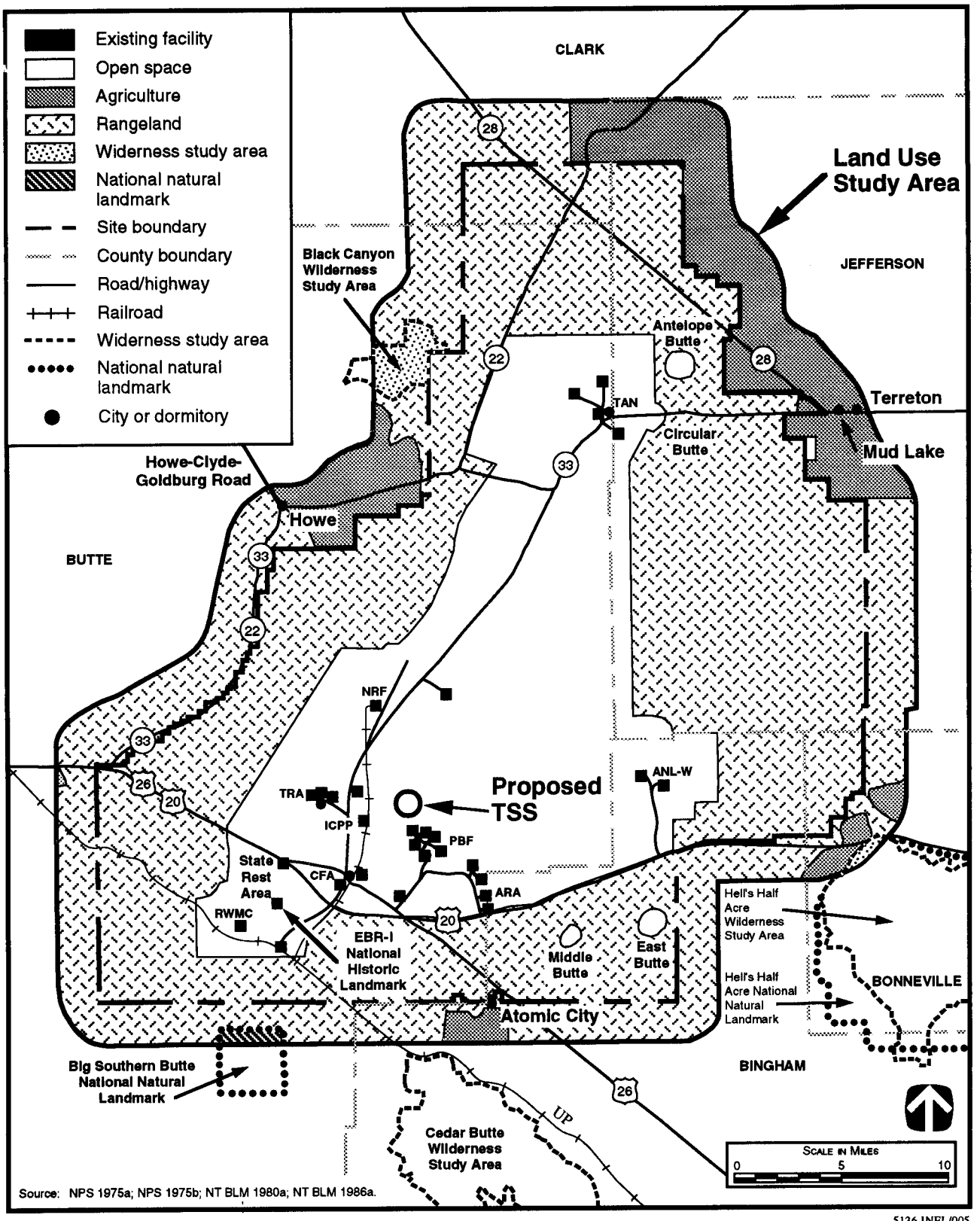


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**FIGURE 4.2.2.1–1.**—*Generalized Land Use at Idaho National Engineering Laboratory and Vicinity.*

residence to the INEL boundary is 1,000 feet east of the facility (approximately 7 miles northwest of the unincorporated community of Mud Lake).

Two National Natural Landmarks border INEL: Big Southern Butte, 1.5 miles south and Hell's Half Acre Lava Field, 1.6 miles southeast. The Bureau of Land Management has also recommended that Congress consider designating Hell's Half Acre Lava Field as a wilderness area (BLM 1980a:10; BLM 1986a:363,373,388).

**Visual Resources.** INEL generally consists of open desert land containing sagebrush. The surrounding volcanic cones, domes, and mountain ranges are visible throughout INEL. The proposed TSS consists of the typical open, undeveloped desert landscape characteristic of the Snake River Plain. The Bureau of Land Management has classified the acreage within INEL as VRM Class 3 (mixed use) and VRM Class 4 (industrial use) (BLM 1980a:10; BLM1986a:363,376,388 with maps). INEL facilities and operating areas maintain industrial uses consistent with these classifications.

The Lost River State Rest Area, located along U.S. Route 20/26 (figure 4.2.2.1–1), is approximately 3 miles southwest of the Test Reactor Area, the closest INEL facility. This viewpoint provides the public the best view of the TSS. The Black Canyon Wilderness Study Area (figure 4.2.2.1–1) is located adjacent to INEL and 9.4 miles west-northwest of Test Area North. Views from this wilderness study area include agricultural land use and the facilities of INEL, including the TSS. Views of the facilities from these points are distant and therefore the facilities have a minor effect on the overall natural appearance of the area. Craters of the Moon National Monument and Wilderness Area are both approximately 12.5 miles southwest from the closest INEL boundary and 34 miles from the proposed TSS.

### 4.2.2.2 *Site Infrastructure*

Section 3.3.2 describes the current missions at INEL. To support these missions, an extensive infrastructure exists as shown in table 4.2.2.2–1. Of critical importance to the proposed action is the electrical power infrastructure at each potential site. The regional electrical power pool area in which INEL is located and from which it draws its power is the Northwest Power Pool Area. Characteristics of this power pool are given in table 4.2.2.2–2.

**TABLE 4.2.2.2–1.—*Baseline Characteristics for Idaho National Engineering Laboratory***

| Current Characteristics | Value |
|---|---|
| **Land** | |
| Area (acres) | 570,000 |
| Roads (miles) | 277 |
| Railroads (miles) | 30 |
| **Electrical** | |
| Energy consumption (MWh per year) | 232,500 |
| Peak load (MWe) | 42 |
| **Fuel** | |
| Natural gas ($ft^3$ per year) | 0 |
| Oil (GPY)[a] | 1,538,800 |
| Coal (ton per year) | 12,500 |
| **Steam** (lb per hour) | 90,000 |

[a] Amount includes fuel oil and propane.
Source: INEL 1993a:5.

**TABLE 4.2.2.2–2.—*Regional Power Pool Electrical Summary for Idaho National Engineering Laboratory***

| Type Fuel | Production[a] (percent) |
|---|---|
| Coal | 34 |
| Nuclear | 3 |
| Hydro/geothermal | 46 |
| Oil/gas | 7 |
| Other[b] | 11 |
| **Total Annual Production:** 256,404,000 MWh | |
| **Total Annual Load:** 250,045,000 MWh | |
| **Energy Exported Annually:** 6,359,000 MWh | |
| **Generating Capacity:** 53,206 MWe | |
| **Peak Demand:** 33,325 MWe | |
| **Capacity Margin[c]:** 13,655 MWe | |

[a] Percentage does not total 100 percent due to round-off error.
[b] Includes power from both utility and nonutility sources.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

#### 4.2.2.3 *Air Quality and Acoustics*

The following describes existing air quality and acoustics, including a review of the meteorology and climatology in the vicinity of INEL. More detailed discussions of the air quality and acoustics methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.1.3.2.

**Meteorology and Climatology.** The climate at INEL and in the surrounding region is characteristically that of a semiarid steppe (Trewartha 1954a). The annual average temperature at INEL is 42 °F; average daily temperatures vary from 16 °F in January to 68 °F in July. The average annual precipitation at INEL is 8.7 inches (IN DOE 1989b). Prevailing winds at INEL are from the southwest through west-northwest with a secondary maximum frequency from the north-northeast to northeast. The annual average wind speed is 7.5 mph. Additional information related to meteorology and climatology at INEL is presented in appendix section B.1.3.2.

**Ambient Air Quality.** INEL is located within the Eastern Idaho Intrastate AQCR 61. None of the areas within INEL and its surrounding counties are designated as nonattainment areas (40 CFR 81.313) with respect to any of the NAAQS for criteria pollutants (40 CFR 50). The nearest nonattainment area for particulate matter is in Pocatello, about 50 miles to the south. A nonattainment area is an area that has air quality worse than the NAAQS for one or more criteria pollutant. Applicable NAAQS and Idaho State ambient air quality standards are presented in appendix table B.1.3.1–1.

Three Prevention of Significant Deterioration (40 CFR 52.21) Class I areas have been designated in the vicinity of INEL: Craters of the Moon National Monument, Idaho, approximately 33 miles west-southwest from the center of the site; Yellowstone National Park, Idaho-Wyoming, approximately 89 miles east-northeast from the center of the site; and Grand Teton National Park, Wyoming, approximately 90 miles east from the center of the site (IN DOE 1991b:4-11).

Since the promulgation of Prevention of Significant Deterioration regulations (40 CFR 52.21) in 1977, Prevention of Significant Deterioration permits were obtained by INEL for two major emission sources: the Coal-Fired Steam-Generating Facility next to the Idaho Chemical Processing Plant (IN DOE 1980a) and the Fuel Processing Restoration Facility (IN ES 1988a), which is not expected to be operated.

Historically, the primary emission sources of criteria air pollutants at INEL are: the calcination of liquid waste, the combustion of coal for steam generation at the Idaho Chemical Processing Plant, and the combustion of fuel oil for heating at various INEL facilities. Other emissions and sources include fugitive particulates from waste-burial activities and coal piles, other processes, vehicles, and temporary emissions from various construction activities. Emission estimates for these sources are presented in appendix table B.1.3.2–2.

Ambient air quality monitoring data collected during the last few years are summarized in appendix table B.1.3.2–1. Data indicate that ambient air concentrations are in compliance with applicable guidelines and regulations. The Idaho Department of Health and Welfare no longer monitors ambient $O_3$, $NO_2$, and lead (Pb) in the vicinity of INEL because previous monitoring indicated that ambient concentrations were very low (IN DHW 1988a).

Ambient concentration limits for hazardous/toxic air pollutants (to be used by the state as one of the criteria in evaluating construction permit applications for a new emission source) have been proposed by the Idaho Department of Health and Welfare (IN DHW 1990a). The annual emission rates of hazardous/toxic air pollutants from existing INEL facilities during 1990 and estimates of maximum 8-hour average ground-level concentrations at the INEL boundary are listed in appendix table B.1.3.2–4. The most significant of these pollutants are acetone, ammonia ($NH_3$), nitric acid ($HNO_3$), and 1,1,1-trichloroethane concentrations. These concentrations are in compliance with respective ambient concentration limits proposed by the Idaho Department of Health and Welfare. These proposed concentration limits are 1 percent of the recognized occupational exposure levels (e.g., 8-hour time-weighted threshold limit values).

Table 4.2.2.3–1 presents the baseline ambient air concentrations for criteria pollutants and other pollutants of concern at INEL. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

**TABLE 4.2.2.3–1.—*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Idaho National Engineering Laboratory, 1989-1991***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Baseline Concentration ($\mu g/m^3$) |
|---|---|---|---|
| **Criteria Pollutant** | | | |
| Carbon monoxide (CO) | 8-hour | 10,000[a] | 6 |
| | 1-hour | 40,000[a] | 21 |
| Lead (Pb) | Calendar Quarter | 1.5[a] | [b] |
| Nitrogen dioxide ($NO_2$) | Annual | 100[a] | 8 |
| Ozone ($O_3$) | 1-hour | 235[a] | [b] |
| Particulate matter ($PM_{10}$) | Annual | 50[a] | 14.3 |
| | 24-hour | 150[a] | 34.5 |
| Sulfur dioxide ($SO_2$) | Annual | 80[a] | 4.2 |
| | 24-hour | 365[a] | 46 |
| | 3-hour | 1,300[a] | 134 |
| **Mandated by Idaho** | | | |
| Total suspended particulates (TSP) | Annual | 60[c] | 40.3 |
| | 24 -hour | 150[c] | 91 |
| **Hazardous Air Pollutants and Other Toxic Compounds** | | | |
| Acetone | 8-hour | 17,800[c] | 0.3 |
| Ammonia | 8-hour | 180[c] | 30 |
| Nitric acid | 8-hour | 50[c] | 10 |
| 1,1,1-Trichloroethane | 8-hour | 19,100[c] | 0.2 |

[a] Federal standard (40 CFR 50).
[b] No longer monitored since previous monitoring indicated very low ambient concentrations.
[c] State standard.
Source: DOE 1992k.

**Acoustics Conditions.** Major noise emission sources within INEL include various industrial facilities, equipment, and machines. At the site boundary, away from most of the industrial facilities at INEL, noise emitted from the site is barely distinguishable from background noise levels.

The acoustic environment along the INEL boundary is assumed to be that of a rural location with typical residual noise levels of 35 to 50 dBA (EPA 1974a). Along highways, traffic contributes to ambient noise levels, especially during peak hours, resulting in significantly higher noise levels than at remote locations. Except for the prohibition of nuisance noise, neither the State of Idaho nor its local governments have established specific numerical environmental noise standards applicable to INEL.

### 4.2.2.4 *Water Resources*

This section describes the surface water and groundwater resources at INEL.

**Surface Water.** Flowing surface water in the INEL area consists of three intermittent streams that drain the adjacent mountains: Big Lost River, Little Lost River, and Birch Creek. The streams usually begin to flow in the spring and are dry by early to midsummer. The Big Lost River and Birch Creek are the only surface waters that enter the site on a regular basis. The Little Lost River does not enter the site under normal flow conditions. Since much of the flow in these streams is diverted upstream for irrigation, it is possible that several years can pass without any flow entering the INEL boundaries (DOE 1991a). There has been no onsite flow of the three streams since 1987 (USGS 1992a). The U.S. Geological Survey (USGS) is responsible for monitoring

the streams; however, the only onsite monitoring station is for the Big Lost River. Surface waters near INEL are depicted in figure 4.2.2.4–1.

The proposed TSS for tritium supply and recycling facilities lies within the drainage basin of the Big Lost River. The Big Lost River flows onto the site at the southern part of its western boundary and flows northeastward to the Big Lost River sinks (Playas 1 through 3) (IN DOE 1985a). Water flow in the Big Lost River is controlled by the MacKay Dam located approximately 45 miles upstream from INEL. Local rainfall and snowmelt are the primary contributors to the surface water flows. Most precipitation is rapidly infiltrated into the soil.

Surface water is not used on INEL as a source of water, nor is it used for wastewater discharge. Nonradioactive liquid effluents are disposed of primarily to a waste ditch, a lined evaporation pond, an industrial waste pond, five different seepage ponds, and sewage treatment facilities (IN DOE 1992d).

Several areas of INEL, such as Test Area North, Test Reactor Area, and Central Facilities Area, currently divert stormwater into drainage ditches and discharge flow into soils away from the work area. A large drainage ditch equipped with an automatic sampler surrounds the Radioactive Waste Management Complex to ensure that radionuclides are not transported from the area by stormwater (DOE 1991a).

Flooding at INEL by the Big Lost River has been averted by a flood diversion system constructed in 1958 and upgraded in 1984. The flood diversion system consists of a small dam to direct flow through a diversion channel into four spreading areas. The flood diversion system is designed to contain a 300-year flood.

**Surface Water Quality.** The Big Lost River (from its source to the playas) is designated by the Idaho Department of Health and Welfare's Water Quality Standards and Wastewater Treatment Requirements for the following uses: agricultural and domestic water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource waters (IN DHW 1992a).

The USGS is responsible for monitoring the surface water quality at INEL. The most recent water samples collected within the facility boundaries were collected from the Big Lost River below the diversion dam in 1985. The results of the analysis and the Idaho Water Quality Standards for the Protection of Domestic Water Supplies are presented in table 4.2.2.4–1. More recent samples are not available because of the intermittent nature of these water bodies. The analytical results indicate that there are no parameters in exceedance of the water quality criteria.

**Surface Water Rights and Permits.** Surface water rights are not an issue at INEL because INEL facilities do not withdraw surface water for use, nor do they discharge effluents directly to natural surface waters.

**Groundwater.** The Snake River Plain aquifer, classified by EPA as a Class I sole-source aquifer, is located beneath the entire INEL site and covers a total area of approximately 9,600 square miles in Southeastern Idaho. The aquifer serves as a primary source for drinking water and crop irrigation in the Snake River Basin. It is composed of 2,000 to 10,000 feet of lava flows, rhyolite, and interbedded sediments (IN Barraclough 1978a) and is believed to contain 1 to 2 billion acre-feet of water.

Groundwater underflow from the Henry's Fork of the Snake River supplies a significant amount of water to the Snake River Plain aquifer below INEL. Additional recharge to the aquifer comes from the Big Lost River, Little Lost River, and Birch Creek, which originate in the mountains to the northwest of INEL, flow onto the site during a few months of the year during wet years, and sink into its porous soils. Precipitation and snow melt also contribute to its recharge. Local groundwater movement is complicated, but overall groundwater flows laterally at an average rate of 5 to 20 feet per day to the south and west as shown in figure 4.2.2.4–2. The groundwater emerges in springs (6.5 million acre-feet annually) along the Snake River from Milner to Bliss, ID, and from Blackfoot to American Falls Reservoir in the region west of Pocatello, ID (DOE 1992e). Depth to the water table ranges from 200 feet below the ground surface in the northeast corner of INEL to 1,000 feet in the southeast corner and approximately 476 feet below the ground surface of the proposed TSS (IN DOE 1986a).

Perched water tables occur in the INEL area. The presence of these perched water bodies is believed to

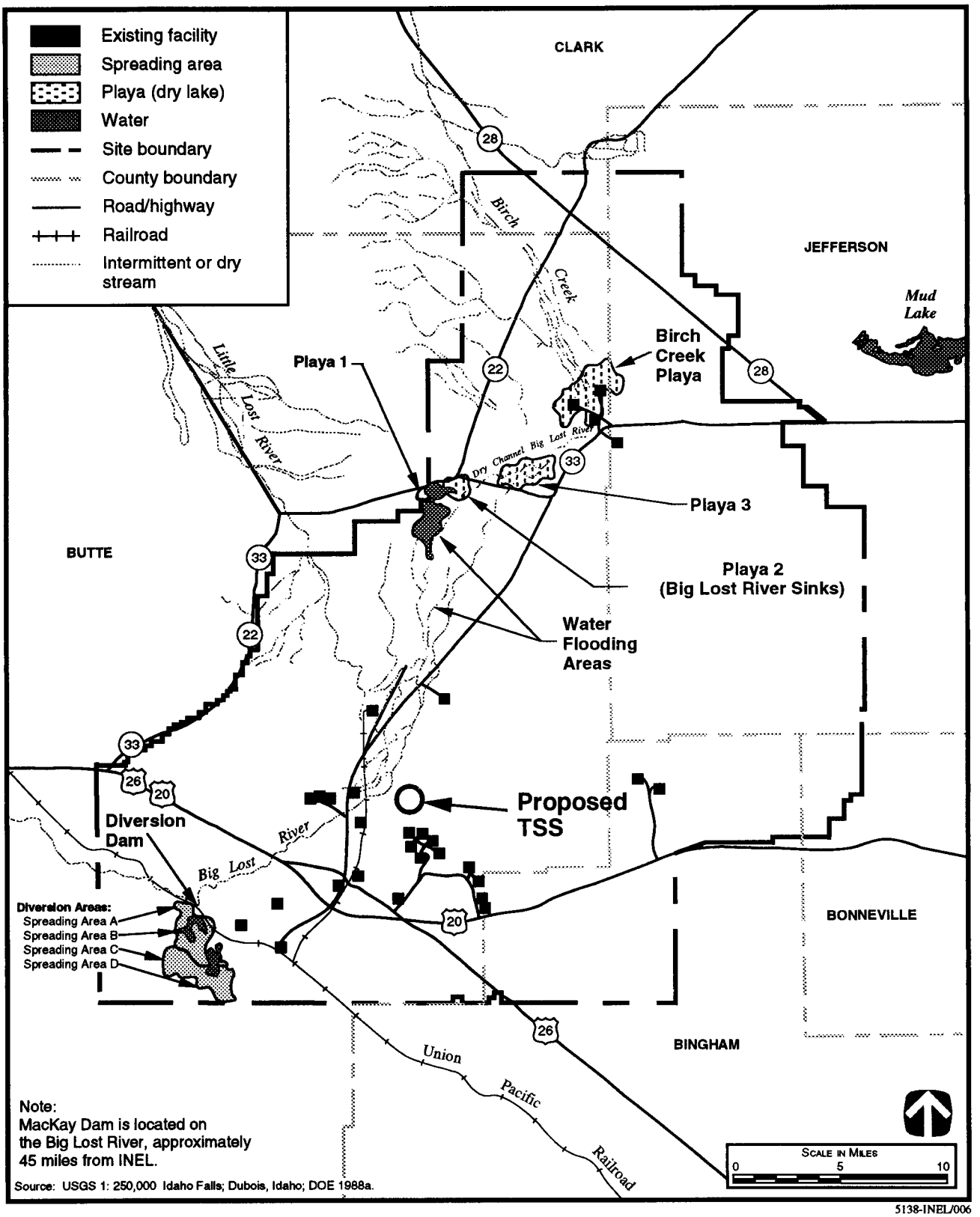


**FIGURE 4.2.2.4–1.**—*Surface Water Features at Idaho National Engineering Laboratory.*

**TABLE 4.2.2.4–1.—*Summary of Surface Water Quality Monitoring at Idaho National Engineering Laboratory***

| | Receiving Water: Big Lost River, 1985 | | |
|---|---|---|---|
| **Parameter** | **Unit of Measure** | **Water Quality Criteria** | **Maximum Water Body Concentration** |
| Arsenic | mg/l | 0.05[a] | 0.002 |
| Barium | mg/l | 1[a] | 0.2 |
| Cadmium | mg/l | 0.01[a] | 0.003 |
| Chromium | mg/l | 0.05[a] | 0.001 |
| Lead | mg/l | 0.05[a] | 0.001 |
| Mercury | mg/l | 0.002[a] | <0.0001 |
| pH | pH units | 6.5-8.5[b] | 8.3 |
| Selenium | mg/l | 0.01[a] | <0.001 |
| Silver | mg/l | 0.05[a] | <0.001 |
| Temperature | °C | 22[a] | 20 |

[a] State of Idaho water quality criteria.
[b] National Secondary Drinking Water Regulations (40 CFR 143). For comparison purpose only, no obligation criteria.
Source: IN DHW 1992a; IN USGS 1985a.

be beneficial to water quality in the Snake River Plain aquifer. These perched water bodies slow waste migration, allow for radioactive decay, and spread any waste plumes over a wider area for greater dilution (DOE 1992e).

**Groundwater Quality**. Two groundwater monitoring networks are operated at INEL, one by the USGS and the other by the Radiological and Environmental Sciences Laboratory. The USGS has drilled more than 120 wells in the Snake River Plain aquifer and 100 in the perched zone on and near INEL. Water supply wells, wells that monitor the migration of constituents from INEL facilities, and offsite water supply wells are routinely sampled for chemical and radiological constituents.

Historically, there has been radionuclide contamination of the Snake River Plain aquifer. Between 1952 and 1988, approximately 30,900 curies (Ci) of tritium were disposed of into wells and infiltration ponds at INEL (mainly from Idaho Chemical Processing Plant and Test Reactor Area). No tritium is currently disposed of at INEL; however, tritium plumes are present in the Snake River Plain aquifer and in perched groundwater under these sites (figure 4.2.2.4–2) (IN USGS 1988a). Tritium occurs at elevated levels in some monitoring wells and has been detected in groundwater near the southern boundary of INEL, 9 miles south of the Idaho Chemical Processing Plant and Test Reactor Area. The average concentration of tritium in water from 26 wells decreased from 250,000 picocuries per liter (pCi/l) in 1961 to 18,000 pCi/l in 1988. In 1990, the highest tritium concentrations occurring in INEL drinking water were in the area of the Central Facilities Area; the concentration ranged from 16,000 to 18,000 pCi/l. The elimination of tritium disposal, radioactive decay, and dilution and dispersion within the groundwater reservoir are factors contributing to a 93-percent decrease in tritium concentration levels from 1961 to 1988 (IN USGS 1990a).

Other radionuclides of significance include strontium-90, cesium-137, and iodine-129. The first two, especially cesium-137, are strongly held on mineral grains in the soils so it is unlikely that either will reach the aquifer in significant amounts. As shown in figure 4.2.2.4–2, plumes have been delineated for strontium and iodine (INEL 1990b).

Samples from four offsite USGS wells beyond the southern and western site boundaries were taken in 1990. Gross alpha and gross beta concentrations of 3 pCi/l and 5 pCi/l, respectively, were measured (DOE 1990a). The concentrations are within the values expected due to leaching of natural radionuclides in the local soil and rock. None of the samples showed detectable concentrations of tritium or gamma-emitting radionuclides.

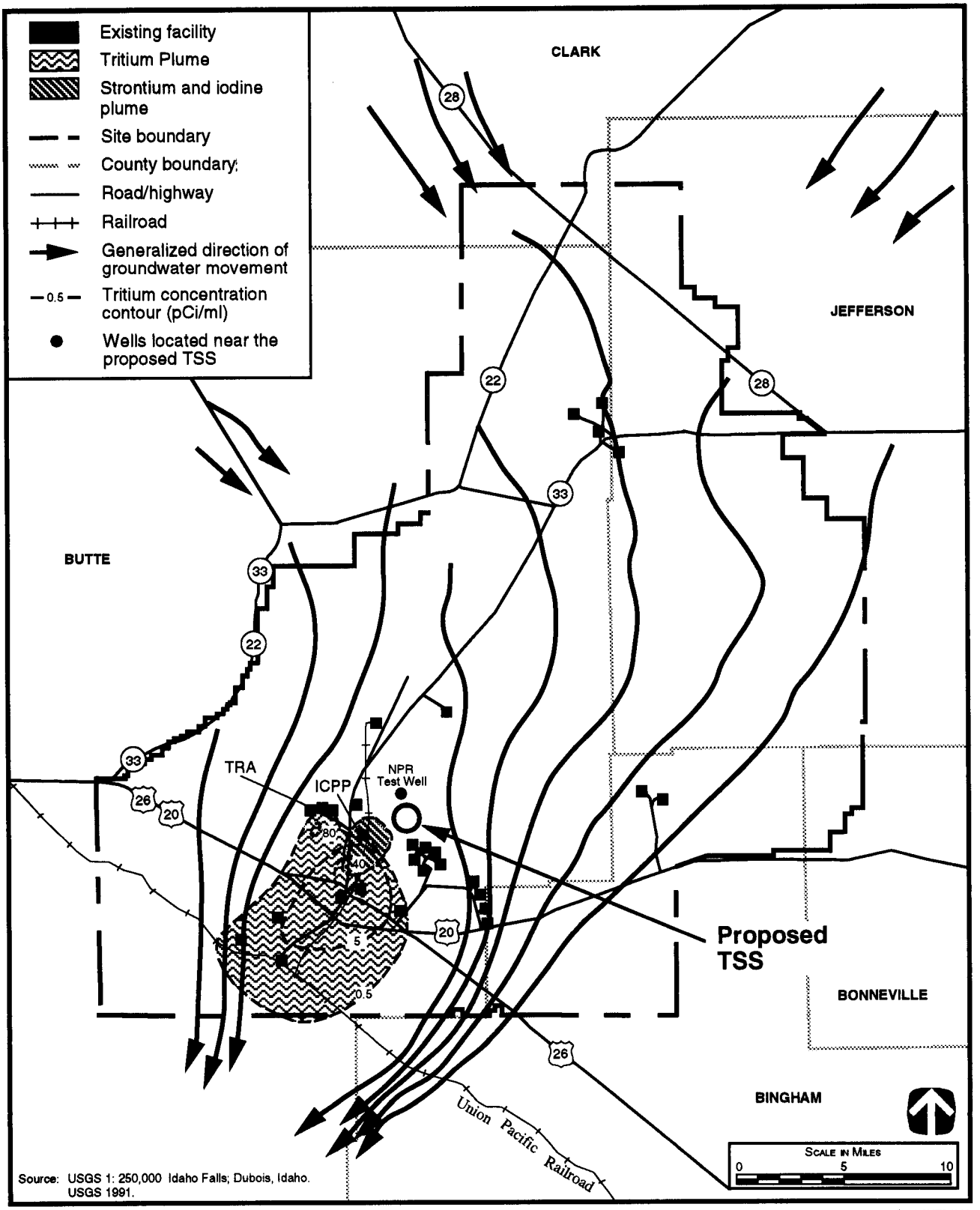


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**FIGURE 4.2.2.4–2.**—*Generalized Groundwater Flow and Groundwater Contamination in Idaho National Engineering Laboratory Area.*

Nonradioactive wastes, including sodium chloride, sulfuric acid, sodium hydroxide, and organics, have also been discharged to ponds within many of the operating areas. In the past, wastewater also has been injected into deep disposal wells at the Test Reactor Area and Idaho Chemical Processing Plant. The total dissolved solids concentrations of the injected wastewaters were approximately twice those present in the natural groundwater (IN USGS 1988a). There are no plans to use injection wells for disposal. Monitoring of the Snake River Plain aquifer for nonradiological constituents, including sodium chloride, total chromium, trace metals, and nitrates, showed concentrations for these contaminants to be at or below background levels at least 2.5 miles inside the nearest site boundary (DOE 1992e).

Only nonradioactive and nonhazardous liquid wastes are currently discharged into the sanitary and service waste disposal systems. All hazardous and radioactive wastes are stored or disposed of in approved facilities designed to preclude groundwater contamination.

Groundwater quality data for 1991 indicate that water quality at the proposed TSS is good with no significant radionuclide or nonradionuclide contamination as shown in table 4.2.2.4–2.

**Groundwater Availability, Use and Rights.** The Snake River Plain aquifer is the source of all water used at INEL (IN DOE 1991b). The combined pumpage of the 27 onsite production wells averaged approximately 2,100 MGY from 1982 through 1985 (IN DOE 1991b). This is 40 percent of the 5,280 MGY of groundwater withdrawn from the aquifer in the Eastern Snake River Plain. Most of the water withdrawn from the aquifer in the Eastern Snake River Plain (4,750 MGY) is used for agriculture (IN DOE 1986a). After use, approximately 63 percent of the quantity of groundwater withdrawn at INEL is disposed of in wells and ponds.

In the INEL ROI, Idaho Falls, Pocatello, and Rigby maintain water supply systems. All of the community drinking water systems draw their raw water from the Snake River Plain aquifer. In 1991, the combined water supply capacity for these systems was approximately 142 MGD. The combined demand averaged about 54 MGD (38 percent of capacity).

**TABLE 4.2.2.4–2.—*Groundwater Quality Monitoring at Idaho National Engineering Laboratory***

| Parameter | Unit of Measure | Water Quality Criteria and Standards[a] | Existing Conditions (1990, 1991) Well No. NPR Test[b] |
|---|---|---|---|
| Alpha (gross) | pCi/l | 15[c] | 3.1 |
| Beta (gross) | pCi/l | 50[c] | 2.2 |
| Barium | mg/l | 2[c] | 0.084 |
| Beryllium | mg/l | 0.004[c] | < 0.0005 |
| Carbon Tetrachloride | mg/l | 0.005[c] | < 0.0002 |
| Chromium | mg/l | 0.1[c] | 0.006 |
| 1,1-Dichloroethylene | mg/l | 0.007[d] | < 0.0002 |
| Tritium | pCi/l | 20,000[c] | 74 |
| Radon | pCi/l | NA | 160 |
| Strontium | mg/l | NA | 300 |
| Tetrachloroethylene | mg/l | 0.005[c] | < 0.0002 |
| 1,1,2-Trichloroethane | mg/l | 0.005[c] | < 0.0002 |
| Trichloroethylene | mg/l | 0.005[c] | < 0.0002 |

[a] For comparison only.
[b] USGS 1991; water quality data.
[c] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[d] National Primary Drinking Water Regulations (40 CFR 141).
Note: NA - not applicable.

DOE has negotiated with the Idaho Department of Water Resources for water rights of 51.7 MGD, not to exceed 11,360 MGY, under the Federal Reserve Doctrine. Currently, INEL's total water usage is 5.7 MGD, representing 11 percent of the 51.7 MGD current INEL negotiated water rights.

#### 4.2.2.5 *Geology and Soils*

**Geology.** INEL occupies a relatively flat area on the northwestern edge of the Eastern Snake River Plain. The INEL area consists of a broad plain that has been built up from the eruptions of multiple flows of basaltic lava. It is bordered by mountains on the north and the overthrust belt on the east. The Eastern Snake River Plain consists of Miocene and younger volcanic rocks that probably rest upon older sedimentary and plutonic rocks, as well as faulted remains of Eocene volcanic rocks.

The oldest faults in the region occur both to the north and south of INEL and are approximately 40 to 65 million years old. The Arco segment of the Lost River fault and the Howe segment of the Lemhi fault are range-front normal faults associated with the Basin and Range Province and have been active during recent geologic time (100,000 to 15,000 years ago). They are considered to be the closest capable faults to INEL within the definition of 10 CFR 100, Appendix A. These faults terminate approximately 19 miles from the INEL boundary (figure 4.2.2.5–1).

INEL is located in Seismic Zone 2 (figure 4.2.2.5–2), meaning that moderate to major damage could occur as a result of earthquakes. Historically there have been several earthquakes in the region surrounding INEL (figure 4.2.2.5–1). However, none of these occurred within approximately 30 miles of the site. The largest historic earthquake that has occurred near INEL took place in 1983, approximately 67 miles to the northwest near Borah Peak in the Lost River Range. The earthquake had a Richter magnitude of 7.3 and a modified Mercalli intensity of VI, with ground acceleration of 0.022 to 0.078 g at INEL (table 4.2.2.5–1) (IN DOE 1991e; INEL 1985a). An earthquake of greater than 5.5 magnitude is to be expected approximately every 10 years within a 200-mile radius of INEL.

No major earthquake activity has occurred on the Eastern Snake River Plain. The only recorded earthquake on the Eastern Snake River Plain with a magnitude greater than 5.5 was the 1905 event that had a magnitude of 5.7. Recent interpretations of the event, however, have suggested that its epicenter was more likely to have been in Utah or Nevada.

The Snake River Plain region has been volcanically active for 400,000 years. The most recent volcanism in the region consisted of lava flows that occurred approximately 1,500 to 2,000 years ago at the present site of Craters of the Moon National Monument. The Hell's Half Acre lava flow, which crosses INEL east of the proposed TSS, dates to 4,100 years ago.

Possible future volcanic occurrences are postulated to be of the same type that took place in the recent past, mainly lava flows. The mean recurrence interval for all types of volcanic activity in the Arco-Big Southern Butte area is suggested to be 3,000 years (IN USGS 1978a).

**Soils.** INEL soils are derived from volcanic and clastic rocks from nearby highlands (IN DOE 1986a). In the southern part of INEL, the soils are gravelly to rocky and generally shallow. The northern portion is composed mostly of unconsolidated clay, silt, and sand. There is no Soil Conservation Service soil survey of Butte County. Consequently, there are few data available for the soils found at the proposed TSS. Generally, the soils are acceptable for standard construction techniques and consist of wind-blown sand and silt lying in patches over a bedrock of basaltic lava. These soils have a low-to-moderate water erosion hazard and a moderate-to-high wind erodibility. Shrink-swell potential is generally low to moderate

#### 4.2.2.6 *Biotic Resources*

The following describes biotic resources at INEL including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area, the discussion focuses first on INEL as a whole and then on the proposed TSS. Scientific names of species identified in the text are presented in appendix C. Also presented in the appendix is a list of threatened and endangered species that may be found on the site or in the vicinity of INEL.

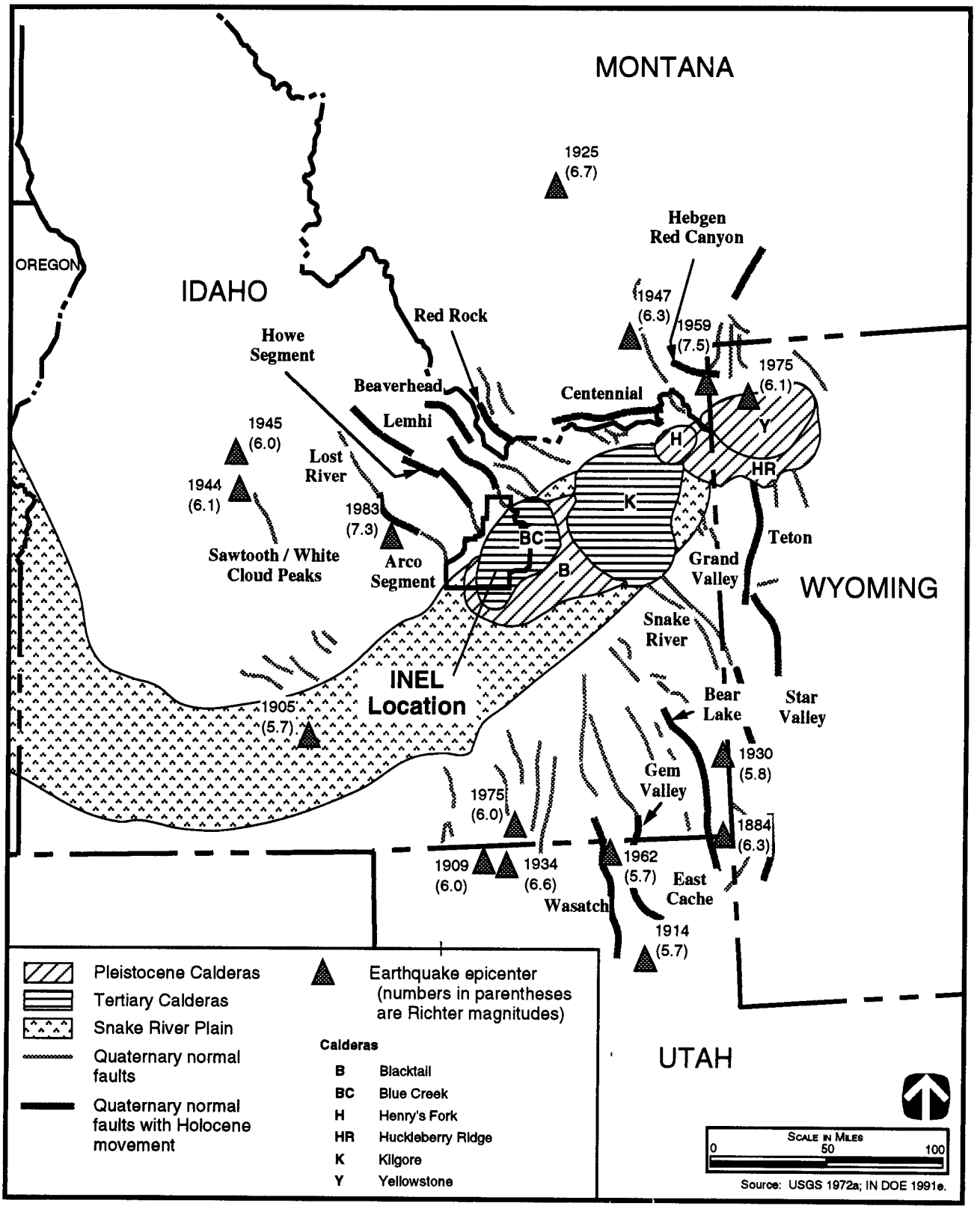


**FIGURE 4.2.2.5–1.**—*Major Fault Systems and Historic Earthquakes in Idaho National Engineering Laboratory Region.*

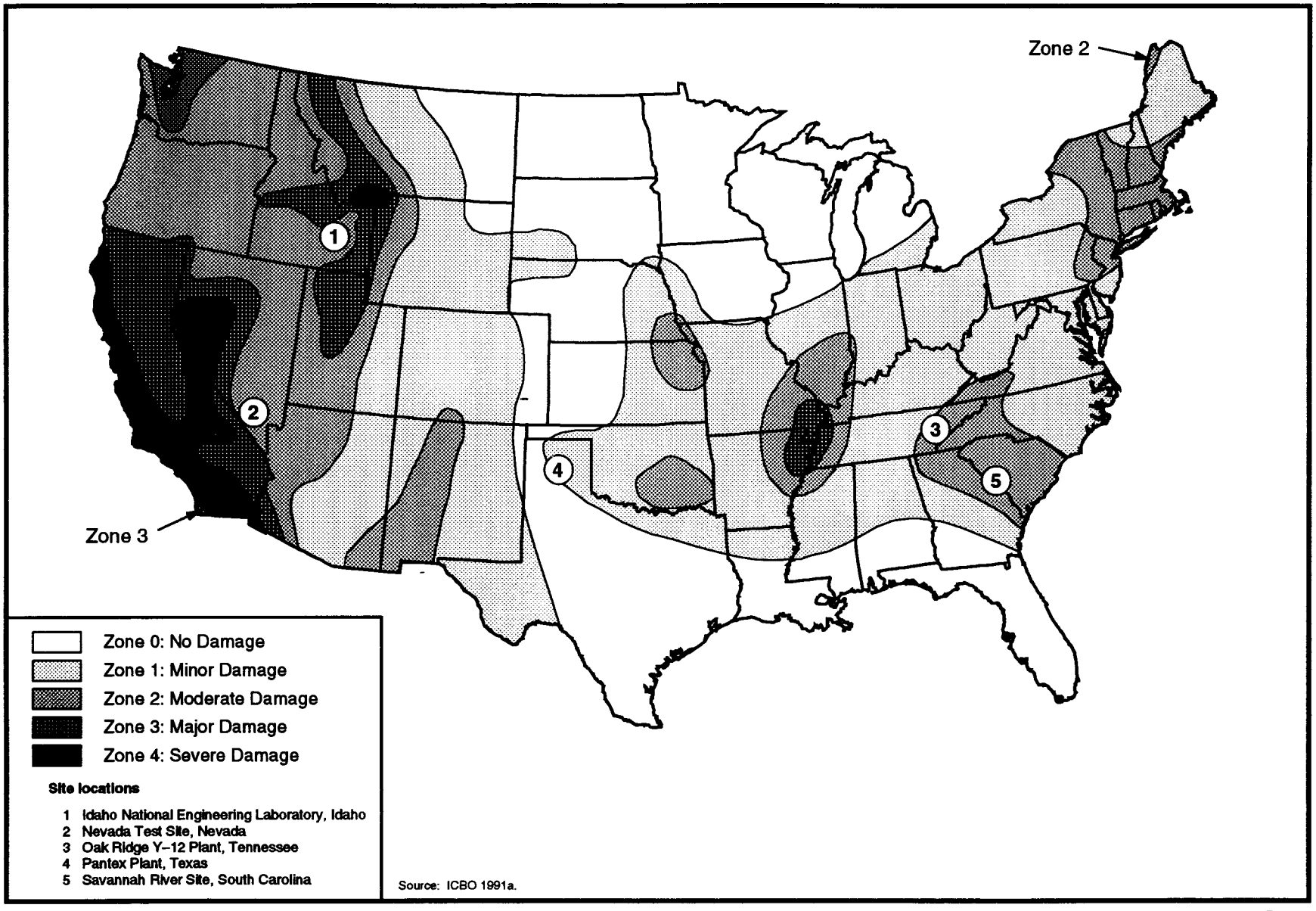


**FIGURE 4.2.2.5–2**—*Seismic Zone Map of the United States.*

**TABLE 4.2.2.5–1.—*The Modified Mercalli Scale of 1931, with Approximate Correlations to Richter Scale and Maximum Ground Acceleration***

| Modified Mercalli Intensity[a] | Observed Effects of Earthquake | Approximate Richter Magnitude[b] | Maximum Ground Acceleration[c] |
|---|---|---|---|
| I | Usually not felt | 2 | negligible |
| II | Felt by persons at rest, on upper floors or favorably placed | 2-3 | <0.003g |
| III | Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake | 3 | 0.003 to 0.007g |
| IV | Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak | 4 | 0.007 to 0.015g |
| V | Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start | 5 | 0.015 to 0.03g |
| VI | Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves and pictures fall off walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake | 6 | 0.03 to 0.09g |
| VII | Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring | 7 | 0.07 to 0.22g |
| VIII | Automobile steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes | | 0.15 to 0.3g |
| IX | General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks | 8 | 0.3 to 0.7g |
| X | Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent | | 0.45 to 1.5g |
| XI | Rails bent greatly; underground pipelines completely out of service | | 0.5 to 3g |
| XII | Damage nearly total; large rocks masses displaced; objects thrown into air; lines of sight distorted | 8+ | 0.5 to 7g |

[a] Intensity is a unitless expression of observed effects.
[b] Magnitude is an exponential function of seismic wave amplitude, related to the energy released.
[c] Acceleration is expressed in relation to the earth's gravitational acceleration (g).
Source: ICSSC 1985a; PPI 1994a.

**Terrestrial Resources.** INEL lies in a cool desert ecosystem dominated by shrub-steppe communities. Most land within the site is relatively undisturbed and provides important habitats for species native to the region. Facilities and operating areas occupy 2 percent of INEL; approximately 60 percent of the areas around the periphery of the site is grazed by sheep and cattle (DOE 1992e). Although sagebrush communities occupy about 80 percent of INEL, a total of 20 plant communities have been identified (figure 4.2.2.6–1). The interspersion of low and big sagebrush communities in the northern portion of INEL, and the juniper communities located in the northwestern and southeastern portions of the site are

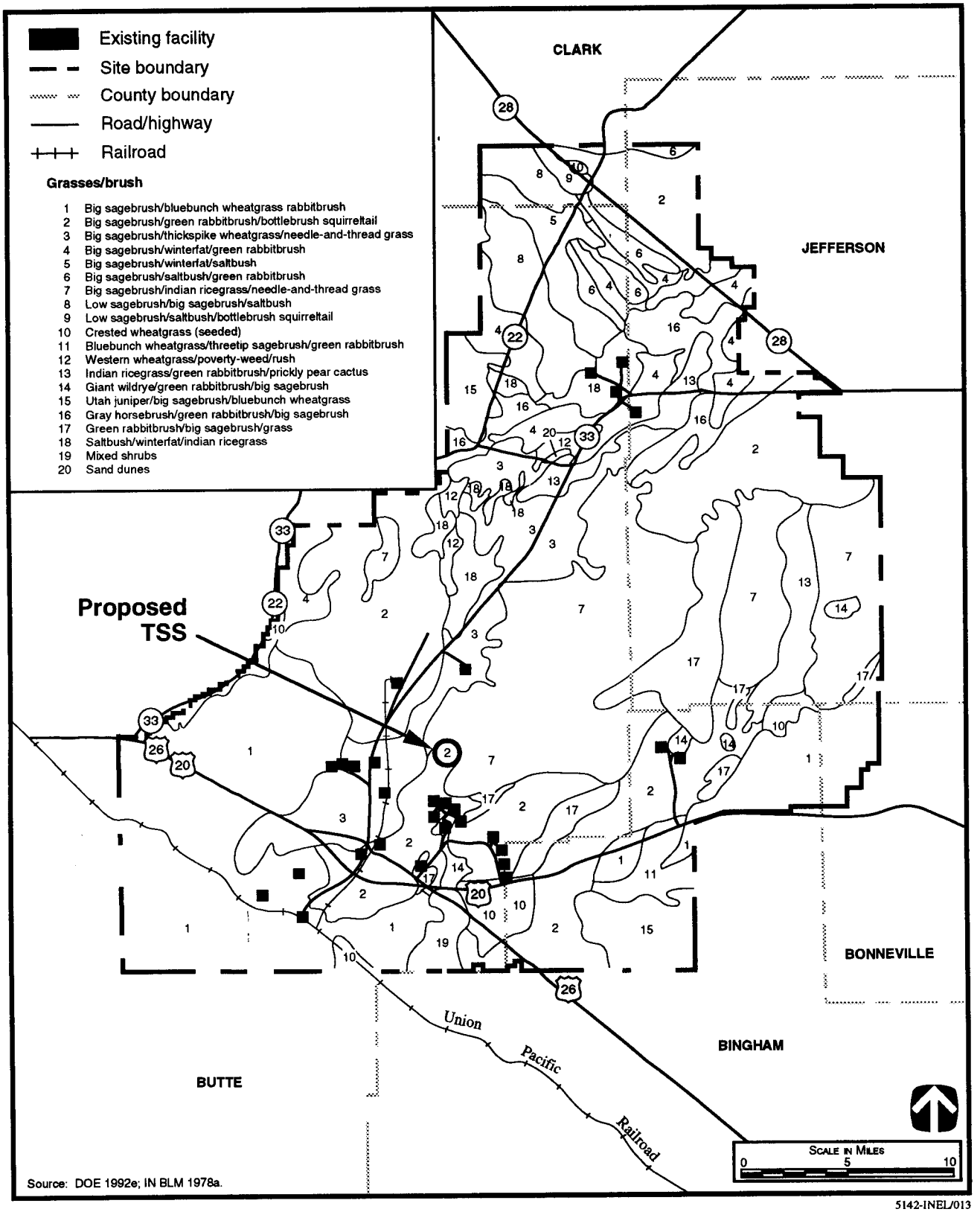


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**FIGURE 4.2.2.6–1.—*Distribution of Plant Communities at Idaho National Engineering Laboratory.***

considered sensitive habitats (IN DOE 1986a). The former provides critical winter and spring range for sage grouse and pronghorn, while the latter is important to nesting raptors and songbirds. These sensitive habitats are located no closer than 8 miles from the proposed TSS. Riparian vegetation, primarily cottonwood and willow, along the Big Lost River and Birch Creek also provides nesting habitat for hawks, owls, and songbirds (DOE 1992e). In total, 399 plant species have been documented on INEL (IN DOE 1978a; IN DOE 1984a).

Within the proposed TSS, shallow soils (which occupy most of the area) are dominated by big sagebrush. In low-lying areas of deep soil, the dominant vegetation is perennial grasses. Isolated stands of juniper also exist in the area (DOE 1992e). Cheatgrass, an aggressive European annual which readily replaces native species in disturbed areas, is also present.

INEL supports numerous animal species, including 1 amphibian, 9 reptile, 184 bird, and 37 mammal species (DOE 1992e). Common animals on INEL include the short-horned lizard, gopher snake, sage sparrow, Townsend's ground squirrel, and black-tailed jackrabbit. Important game animals include the sage grouse, mule deer, elk, and pronghorn. During some winters 4,500 to 6,000 pronghorn, or about 30 percent of Idaho's total population, may be found on INEL. Pronghorn wintering areas are located in the northeastern portion of the site, in the area of the Big Lost River sinks, in the west central portion of the site along the Big Lost River, and in the south central portion of the site (IN DOE 1978a). The latter two areas are both about 4 miles from the proposed TSS. Hunting is permitted only within one-half mile of the northern site boundary. Pronghorn, which is the only species taken, are hunted in order to control damage to agricultural land (INEL 1992a:2). Numerous raptors and carnivores are also found on INEL and include the golden eagle and prairie falcon, and coyote and mountain lion, respectively (IN DOE 1986a). A variety of migratory birds has been found at INEL. Migratory birds, their nests and eggs, are protected by the *Migratory Bird Treaty Act.* Eagles are similarly protected by the *Bald and Golden Eagle Protection Act.*

Extensive wildlife surveys of the proposed TSS have not been conducted. However, due to the similarity of habitat conditions on these sites to other areas of INEL, animal species composition would be expected to closely resemble that of the rest of INEL. Pronghorn use of the area is relatively low (DOE 1992h).

**Wetlands.** The Big Lost River spreading areas and Big Lost River sinks are seasonal wetlands and are located approximately 10 miles southwest and 12 miles north of the proposed TSS, respectively (figure 4.2.2.4–1). These areas can provide more than 2,000 acres of wetland habitat during wet years. Riparian wetland vegetation exists along the Big Lost River and along Birch Creek. Plants found along the Big Lost River, which is located 1.5 miles west of the proposed TSS, are in poor condition due to recent years of only intermittent flows. The river has flowed onsite most recently in 1986 and 1993.

National Wetland Inventory maps prepared by the U.S. Fish and Wildlife Service (USFWS) have been completed for most of INEL. The National Wetland Inventory maps indicate that the primary wetland areas are associated with the Big Lost River, the Big Lost River Spreading Areas, and the Big Lost River sinks (figure 4.2.2.4–1), although smaller (less than 1 acre) isolated wetlands also occur. Wetlands associated with the Big Lost River are classified as riverine/intermittent, indicating a defined stream channel with flowing water during only part of the year. The National Wetland Inventory maps indicate that there are no designated wetlands in the area of the proposed TSS.

**Aquatic Resources.** Aquatic habitat on INEL is limited to the Big Lost River, Little Lost River, Birch Creek, and a number of liquid-waste disposal ponds (figure 4.2.2.4–1). All three streams are intermittent and drain into 4 sinks in the north-central part of INEL. Five species of fish have been observed in the Big Lost River including trout, mountain whitefish, speckled dace, shorthead sculpin, and kokanee salmon (DOE 1992e). Due to drought and upstream diversions, the Big Lost River has flowed onto the site only once since 1986 (i.e., in 1993).

The Little Lost River, located west of the site, and Birch Creek, located north of the proposed TSS, enter INEL only during periods of high flow (IN DOE nda). Surveys of fish in these surface water bodies have not been conducted. The liquid waste disposal

ponds on INEL, while considered aquatic habitat, do not support fish (INEL 1992a:4). No aquatic habitat occurs on the proposed TSS, located about 1.5 miles east of the Big Lost River.

**Threatened and Endangered Species.** Twenty-five Federal- and state-listed threatened, endangered, and other special status species have been identified on and in the vicinity of INEL (appendix table C–2). Five of these species may occur in the vicinity of the proposed TSS (table 4.2.2.6–1). No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on INEL (DOE 1992e).

The pygmy rabbit is common on INEL, but its distribution is patchy (DOE 1994). The Townsend's western big-eared bat, which roosts in caves on INEL, has not been observed in the area of the proposed TSS, but could potentially occur. The ferruginous hawk is expected to use the proposed site area on a regular basis (DOE 1992e). Nesting habitat exists on INEL for the loggerhead shrike, which is found throughout the site. Federal candidate species do not receive legal protection under the *Endangered Species Act*, but USFWS recommends that impacts to these species be considered in project planning since these species may become listed in the future.

The State of Idaho does not maintain a list of threatened or endangered plant species. Plants that are considered rare in Idaho are included in a State Watch List. Only the tree-like oxytheca, listed by the state as a sensitive species, has been found in the area of the proposed TSS (DOE 1992e).

#### 4.2.2.7 *Cultural and Paleontological Resources*

**Prehistoric Resources.** Prehistoric site types identified on INEL include residential bases, campsites, rockshelters, hunting blinds, rock alignments, lithic quarries, and limited activity locations including lithic and ceramic scatters, hearths, and concentrations of fire-affected rock. Since 1984, 93 cultural resource surveys have been conducted, and approximately 4 percent of INEL has been inventoried for cultural resources. Of the 803 prehistoric sites that have been recorded, approximately 95 percent are lithic scatters or locations. Most have not yet been formally evaluated and are considered potentially eligible for the National Register of Historic Places (NRHP).

Cultural resources surveys of the proposed TSS and potential access corridors (INEL 1991a:4) have identified 14 sites with buried remains, 3 stone circle sites, 42 lithic scatters, and 1 prehistoric/historic site. Approximately 19 percent of the TSS has been intensively surveyed and the remaining area has received only reconnaissance-level study. Based on current studies, additional sites are likely to occur and are regarded as potentially eligible for the NRHP, pending further evaluation.

**TABLE 4.2.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May be Found on the Site or In the Vicinity of Proposed Tritium Supply Site at Idaho National Engineering Laboratory***

| Species | Status [a] Federal | Status [a] State | Known or Potential Habitat/Location |
|---|---|---|---|
| **Mammals** | | | |
| Pygmy rabbit | C2 | NL | Tall sagebrush clumps |
| Townsend's western big-eared bat | C2 | SSC | Cave roost, forage throughout |
| **Birds** | | | |
| Ferruginous hawk[b] | C2 | SSC | Dry, open country - forage/nest |
| Loggerhead shrike | C2 | NL | Semi-open areas with lookout perch |
| **Plants** | | | |
| Tree-like oxytheca | NL | S | Sandy areas in sagebrush zone |

[a] Status: C2 - candidate, Category 2 (possible appropriate to list); NL - not listed; S - sensitive (designated by the Idaho Native Plant Society); SSC - state, special concern.

[b] Species known to occur on proposed TSS

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; DOE 1992e; DOE 1994e; IN DFG 1992a; IN DOE 1984a.

**Historic Resources.** About 30 historic resources have been identified on INEL; most are related to either agriculture (e.g., homesteads and canals) or ranching (e.g., sheep and cattle camps). Two historic sites are listed on the NRHP. The Experimental Breeder Reactor I, the first reactor to achieve a self-sustaining chain reaction using plutonium instead of uranium as the principal fuel component, is a National Historic Landmark. Goodale's Cutoff, an historic trail, is still recognizable in the southwestern corner of INEL and is currently listed on the NRHP. Various other nuclear reactors and associated buildings, such as those at Auxiliary Reactor Area-I, -II, -III, the Borax Reactor, Materials Test Reactor, Engineering Test Reactor, and the Hot Shop, are considered eligible for the NRHP (INEL 1991a:1). Although such facilities are not yet 50 years old, they are of exceptional scientific and engineering significance and have played major roles in the development of nuclear science since World War II.

Only one site with historic content has been identified on the proposed TSS. The historic content consists of early household debris and may be potentially eligible for the NRHP, pending further evaluation. Based on current studies, additional historic sites are likely to occur in unsurveyed portions of the TSS.

**Native American Resources.** At the time of Euro-American contact, the area was inhabited by nomadic hunters and gatherers consisting of two linguistically distinct groups: the Shoshone and the Bannock. Horses enabled the Shoshone and Bannock to increase their foraging range, congregate in larger groups, and protect their possessions from other groups. Winter camps were reportedly scattered along major river drainages. Groups dispersed during the other seasons, probably moving across what is now INEL as they utilized floral and faunal resources and obsidian from Big Southern Butte or Howe Point.

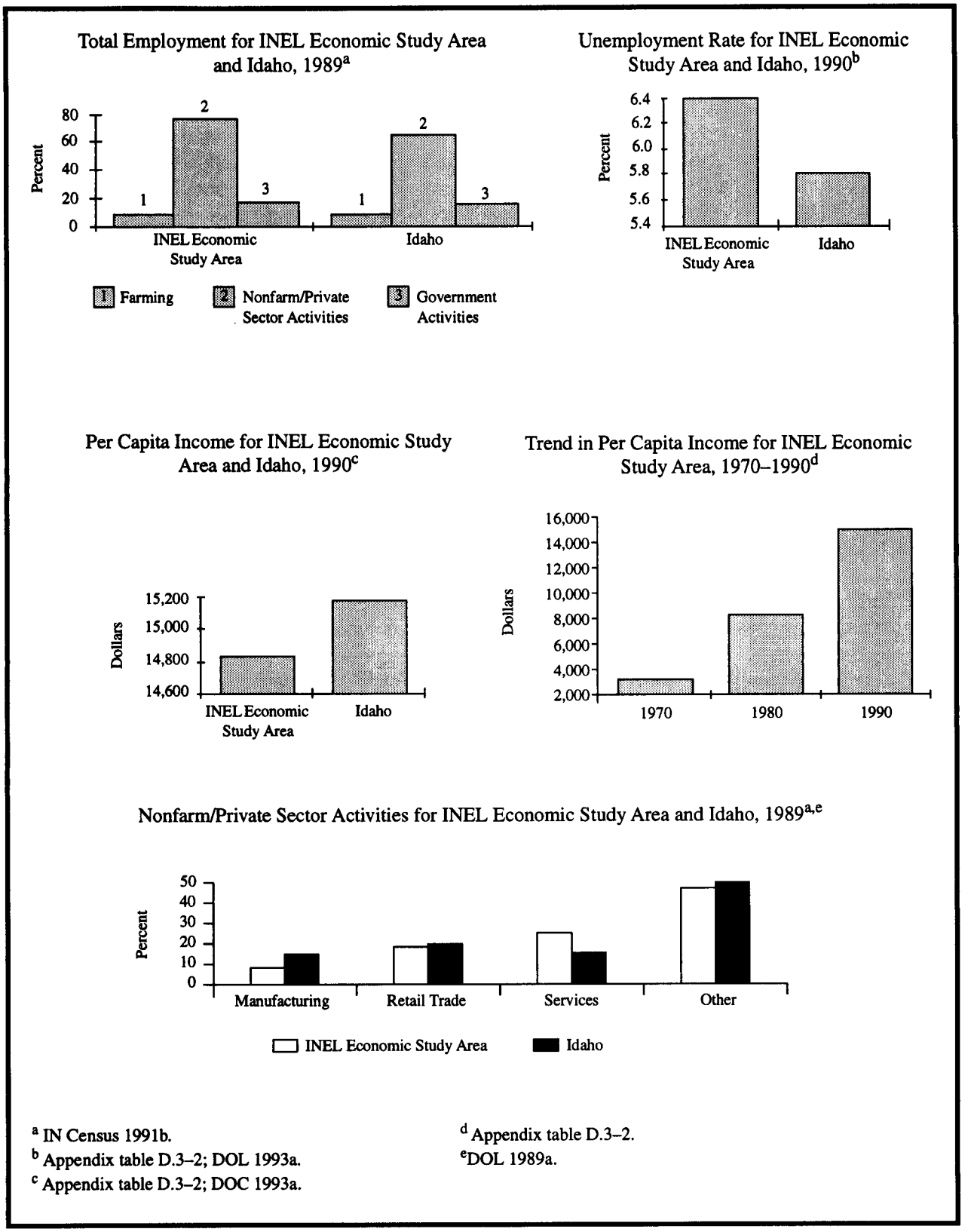
Important Native American resources that might be found in the proposed project areas include buttes, caves, village shrines, rock art, burials, and vision quest sites. INEL recently initiated general consultation with the Shoshone-Bannock tribe. While specific sites or traditional use areas have not yet been identified, the Shoshone and Bannock tribes consider INEL part of their ancestral homeland and have expressed support for the use of scientific methods to preserve cultural resources.

**Paleontological Resources.** No paleontological localities have been identified within the proposed TSS. No lava tubes, caves, or rock shelters that might be expected to contain fossils are visible on the surface. However, lava tubes and caves containing paleontological materials may be buried beneath the aeolian sediments. Because these assemblages may contain both vertebrate and floral remains, such localities would have high research potential.

#### 4.2.2.8 *Socioeconomics*

Socioeconomic characteristics addressed at INEL include employment and local economy, population, housing, public finance, and local transportation. Statistics for employment and local economy are based on the economic study area that encompasses 13 counties around INEL. The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for the remaining socioeconomic characteristics are based on the ROI, a 5-county area in which 98 percent of all INEL employees reside: Bannock County (5 percent), Bingham County (9 percent), Bonneville County (76 percent), Butte County (2 percent), and Jefferson County (6 percent). (See figure 4.2–1 for a map of counties and cities.) Fiscal characteristics of the jurisdictions in the INEL ROI are presented in the public finance section in appendix tables D.3–11 and D.3–12. The school districts most likely to be affected by the proposed action include Pocatello, Blackfoot, Shelley, Snake River, Bonneville, Idaho Falls, Arco, Jefferson, Ririe, and West Jefferson. Assumptions, assessment methodologies, and supporting data are presented in appendix D.

**Employment and Local Economy.** Employment and local economy statistics for the INEL economic study area are presented in appendix table D.3–2 and summarized in figure 4.2.2.8–1. Between 1970 and 1990, the civilian labor force in the economic study area increased 53 percent. The unemployment rate in the economic study area in 1990 was slightly higher than the State of Idaho rate and the 1990 per capita income in the economic study area was slightly lower than the state per capita income.




[a] IN Census 1991b.
[b] Appendix table D.3–2; DOL 1993a.
[c] Appendix table D.3–2; DOC 1993a.
[d] Appendix table D.3–2.
[e] DOL 1989a.

**FIGURE 4.2.2.8–1.—*Economy for Idaho National Engineering Laboratory Economic Study Area.***

As shown in figure 4.2.2.8–1, the percentage of total employment involving farming and governmental activities in the economic study area was approximately the same as in the state. Nonfarm private sector activities of manufacturing, retail trade, and services were similar in the economic study area and the state overall, except that the state had a higher percentage of employment in manufacturing while the economic study area had a higher percentage in services.

In 1990, INEL employed 11,100 persons (8.7 percent of the total economic study area employment), increasing from 6,755 persons in 1970. Historical and future employment at INEL and the distribution of INEL employees by place of residence in the ROI are presented in appendix tables D.2.1–1 and D.3.–1, respectively.

**Population and Housing.** Population and housing distribution in the ROI is presented in appendix tables D.3–5 and D.3–8 and summarized in figure 4.2.2.8–2. Overall, the percent increase in population in the ROI from 1970 to 1990 was 9 percent lower than the state population increase.

The counties of Bonneville and Jefferson experienced population increases between 1970 and 1990 approximately equal to that of the state, while the counties of Bannock and Bingham experienced a growth rate 15 percent lower than that of the state. Butte County experienced a slight population decrease (less than 1 percent) between 1970 and 1990.

Between 1970 and 1990, housing units in the ROI experienced a slightly lower (8 percent) increase compared to state housing unit increases. Homeowner and rental vacancy rates in the ROI in 1990 were similar to those of the state.

**Public Finance.** Financial characteristics of the local jurisdictions in the ROI that are most likely to be affected by the proposed action include total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.3–11 and D.3–12, and figure 4.2.2.8–3 summarizes local governments' revenues less their expenditures.

**Local Transportation.** Vehicular access to INEL is provided by U.S. Routes 20 and 26 to the south and State Routes 22 and 33 to the north. Both U.S. Routes 20 and 26 and State Routes 22 and 33 share rights-of-way adjacent to INEL (figure 4.2–1). Road segments providing access to INEL experience varying levels of traffic congestion. Potential disruptions to the traffic flow caused by accidents or maintenance activities are usually minor. No major improvements are scheduled for those roadway segments providing immediate access to INEL (figure 4.2.1–1) (IN DOT 1991a).

A fleet of government-owned, contractor-operated passenger buses operates between INEL facilities and communities within the ROI. Approximately 4,000 employees use this transportation daily. The major railroad in the ROI is the Union Pacific Railroad. The railroad's MacKay branch provides rail service to the southern portion of INEL. A DOE-owned spur connects the Union Pacific Railroad to INEL by a junction at Scoville Siding. There are no navigable waterways within the ROI capable of accommodating waterborne transportation of material shipments to INEL.

Fanning Field in Idaho Falls and Pocatello Municipal Airport in Pocatello provide jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located throughout the ROI (IN DOT 1991a).

### 4.2.2.9 *Radiation and Hazardous Chemical Environment*

The following provides a description of the radiation and hazardous chemical environment at INEL. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

**Radiation Environment.** Major sources of background radiation exposure to individuals in the vicinity of INEL are shown on table 4.2.2.9–1. All annual doses to individuals from background

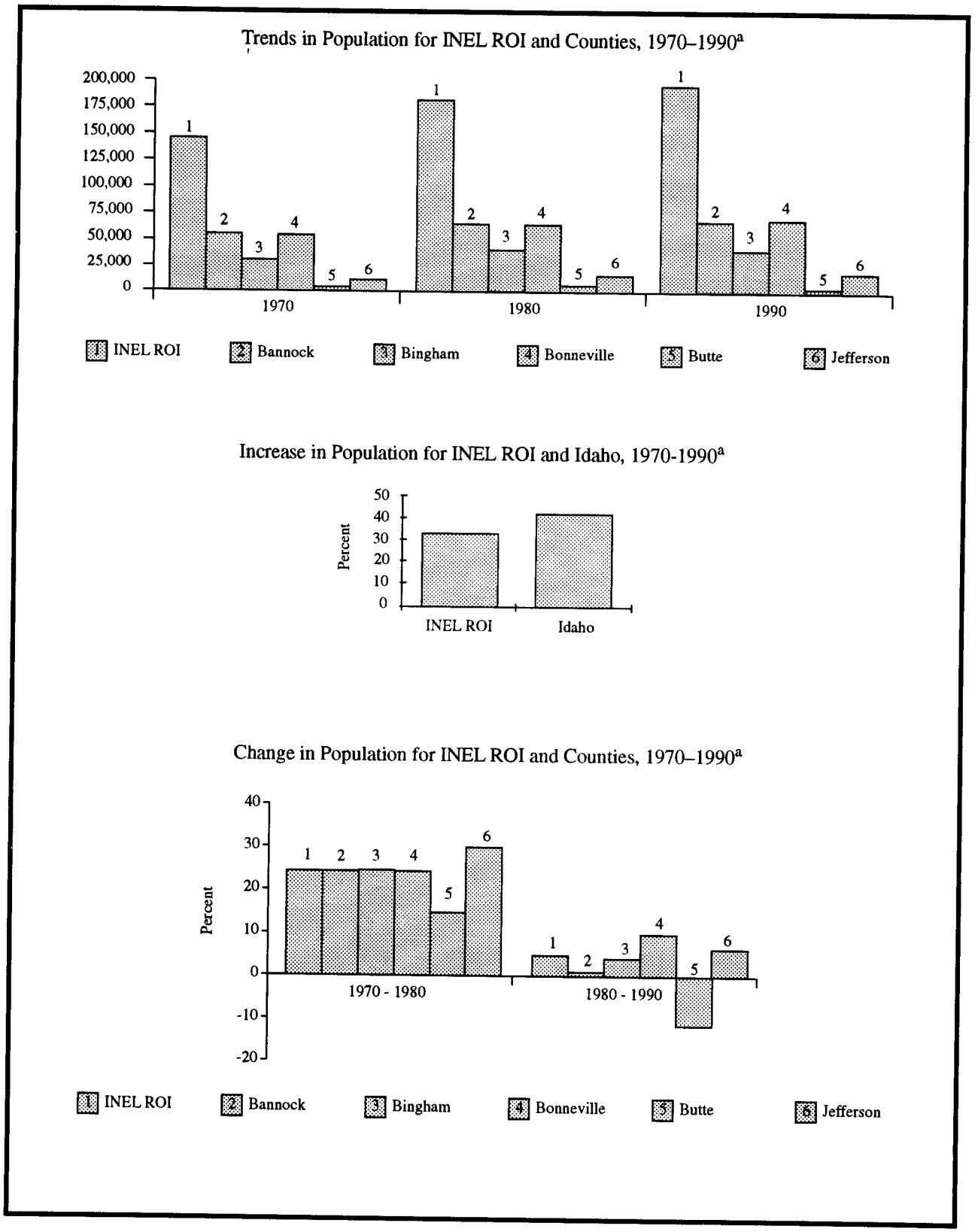
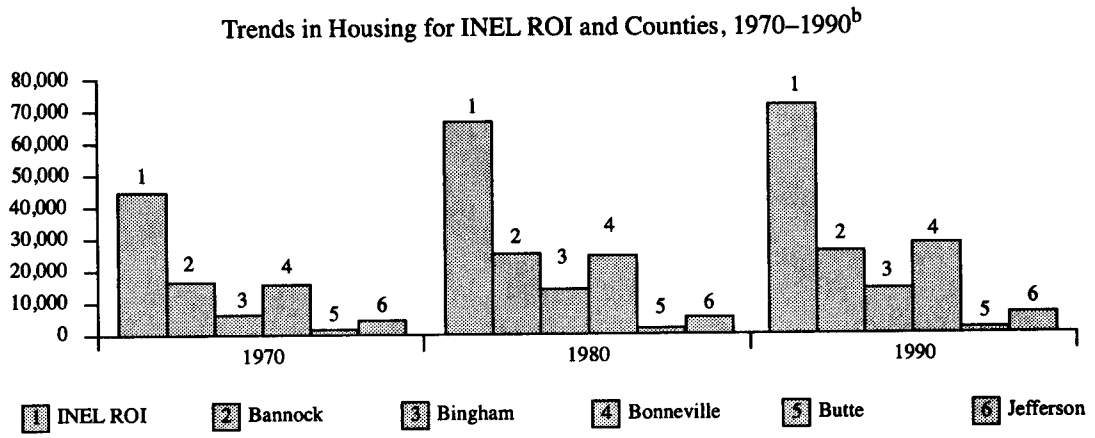
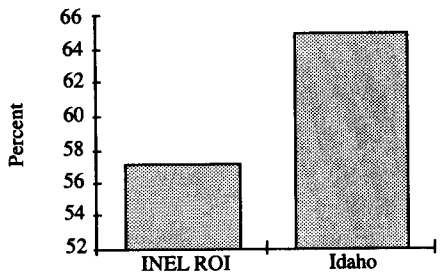
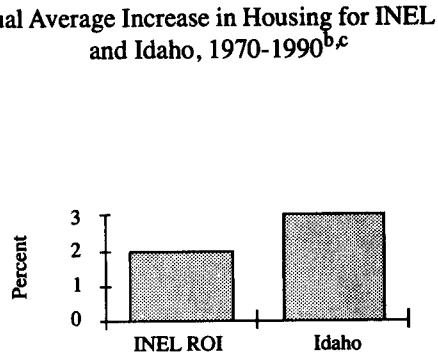
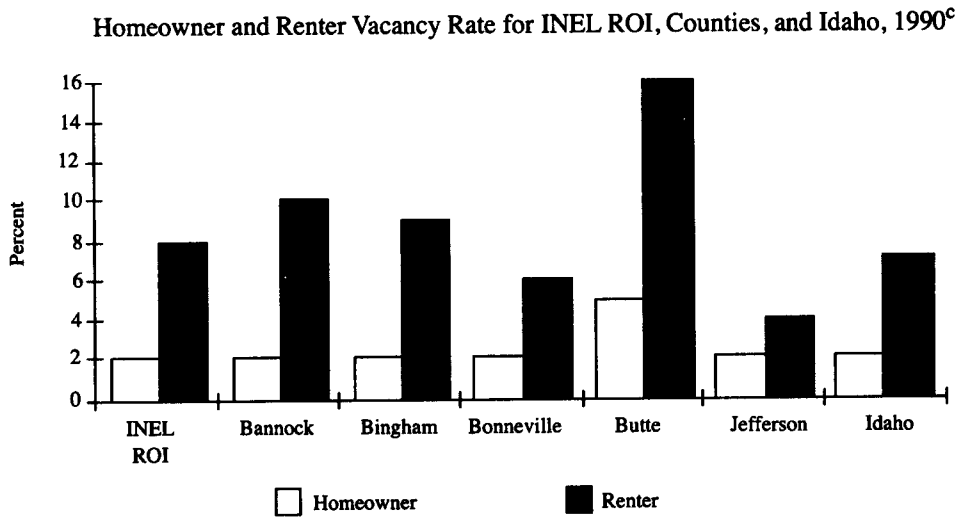



**FIGURE 4.2.2.8–2.—*Population and Housing for Idaho National Engineering Laboratory Region-of-Influence* [Page 1 of 2].**




[a] Appendix table D.3–5.
[b] Appendix table D.3–8.
[c] Census 1972a; Census 1982a; IN Census 1991a.

**FIGURE 4.2.2.8–2.—*Population and Housing for Idaho National Engineering Laboratory Region-of-Influence* [Page 2 of 2].**

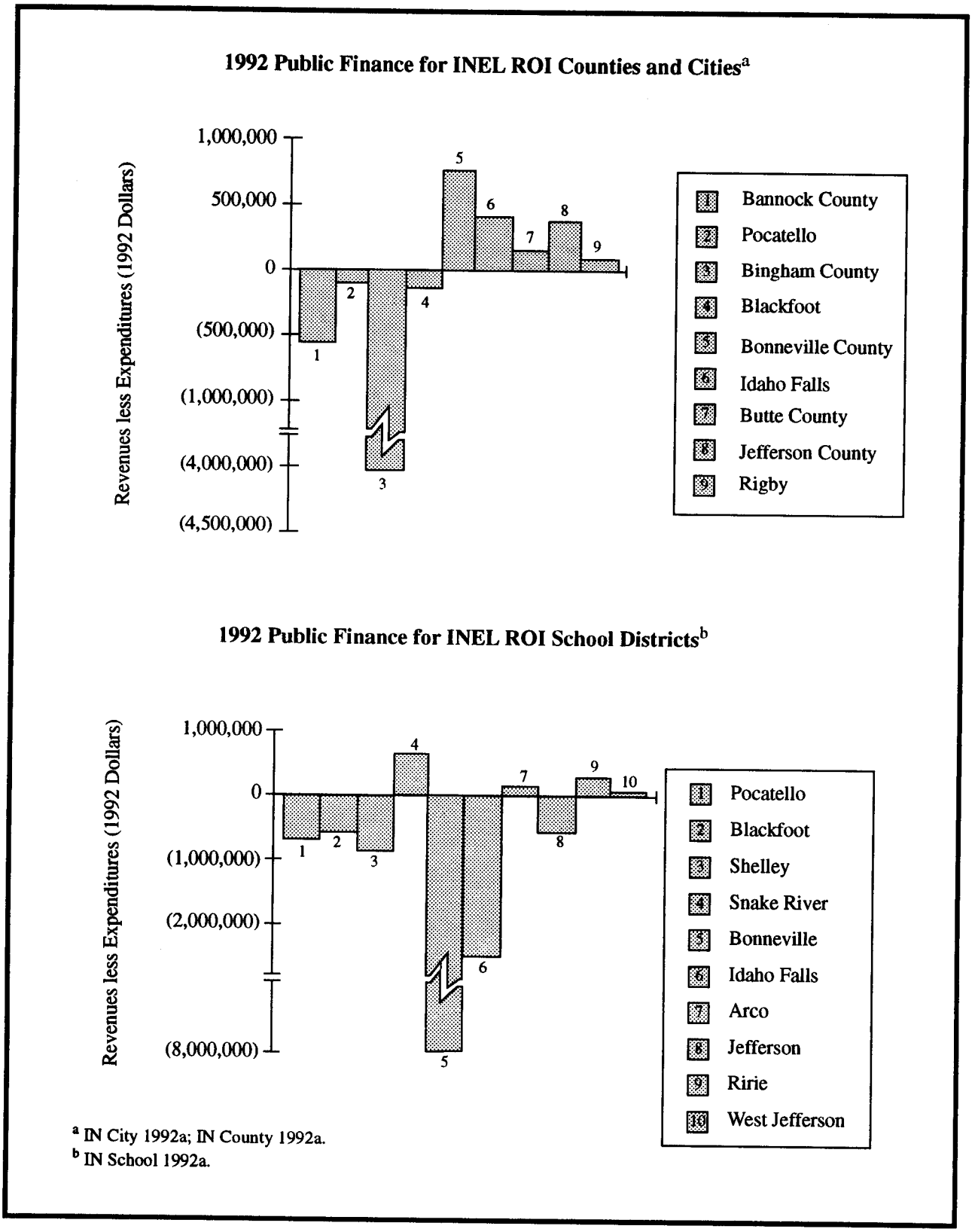



**FIGURE 4.2.2.8–3.**—***1992 Local Government Public Finance for Idaho National Engineering Laboratory Region-of-Influence.***

**TABLE 4.2.2.9–1.—*Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Idaho National Engineering Laboratory Operations***

| Source | Committed Effective Dose Equivalent (mrem/yr) |
|---|---|
| **Natural Background Radiation**[a] | |
| Cosmic radiation | 39 |
| External terrestrial radiation | 74 |
| Internal terrestrial radiation | 40 |
| Radon in homes (inhaled) | 200 |
| **Other Background Radiation**[b] | |
| Diagnostic X-rays and nuclear medicine | 53 |
| Weapons test fallout | <1 |
| Air travel | 1 |
| Consumer and industrial products | 10 |
| **Total** | 418 |

[a] IN DOE 1993b. Value for radon is an average for the United States.
[b] NCRP 1987a.

radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to INEL operations.

Releases of radionuclides to the environment from INEL operations provide another source of radiation exposure to individuals in the vicinity of INEL. The radionuclides and quantities released from INEL operations in 1992 are listed in *The Idaho National Laboratory Site Environmental Report for Calendar Year 1992* (DOE/ID-12082 (92)). The doses to the public resulting from these releases are presented in table 4.2.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1992 report were used in the development of the reference environment (No Action) radiological releases at INEL in the year 2010 (section 4.2.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (appendix section E.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from INEL operations in 1992 is estimated to be approximately $2.0 \times 10^{-9}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of INEL operations is about 2 chances in 1 billion. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Approximately $1.5 \times 10^{-5}$ excess fatal cancers were estimated from normal operations in 1992 to the population living within 50 miles of INEL. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate, associated with cancer, for the entire U.S. population was 0.2 percent per year (Almanac 1993a). Based on this national mortality rate, the number of fatal cancers from all causes expected during 1992 in the population living within 50 miles of INEL was 243. This

**TABLE 4.2.2.9–2.—*Doses to the General Public from Normal Operations at Idaho National Engineering Laboratory, 1992 (committed effective dose equivalent)***

| | Atmospheric Releases | | Liquid Releases | | Total | |
|---|---|---|---|---|---|---|
| **Affected Environment**[a] | **Standard**[b] | **Actual** | **Standard**[b] | **Actual** | **Standard**[b] | **Actual** |
| Maximally exposed individual (mrem) | 10 | 0.004 | 4 | 0.0 | 100 | 0.004 |
| Population within 50 miles[c] (person-rem) | None | 0.030 | None | 0.0 | 100 | 0.030 |
| Average individual within 50 miles[d] (mrem) | None | 0.00025 | None | 0.0 | None | 0.00025 |

[a] From IN DOE 1993b.
[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834. If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.
[c] In 1992, this population was approximately 121,500.
[d] Obtained by dividing the population dose by the number of people living within 50 miles of the site.

number of expected fatal cancers is much higher than the estimated $1.5 \times 10^{-5}$ fatal cancers that could result from INEL operations in 1992.

Workers at INEL receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.2.2.9–3 includes the average, maximum, and total occupational doses to INEL workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (appendix section E.2), the number of excess fatal cancers to INEL workers from operations in 1992 is estimated to be 0.030.

**TABLE 4.2.2.9–3.—*Doses to the Worker Onsite from Normal Operations at Idaho National Engineering Laboratory, 1992 (committed effective dose equivalent)***

| Affected Environment | Onsite Releases and Direct Radiation | |
|---|---|---|
| | Standard[a] | Actual |
| Average worker[b] (mrem) | None | 14.2 |
| Maximally exposed worker[b] (mrem) | 5,000 | 1,000 |
| Total workers[b] (person-rem) | None | 75 |

[a] From 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] From DOE 1993p. The number of badged workers in 1992 was approximately 5,270.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in *The Idaho National Laboratory Site Environmental Report for Calendar Year 1992* (DOE/ID-12082(92)). The concentrations of radioactivity in various environmental media (air, water, and soil) in the site region (onsite and offsite) are also presented in that document. INEL operations contribute negligible radioactivity to these media.

**Chemical Environment.** The background chemical environment important to human health consists of: the atmosphere, which may contain toxic chemicals which can be inhaled; drinking water, which may contain toxic chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.2.2.3 and 4.2.2.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements, (e.g., air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at INEL via inhalation of air containing pollutants released to the atmosphere by INEL operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway. At INEL, the risk to public health from water ingestion and direct exposure pathways is low because the surface water resource (Big Lost River) is not used either for drinking or as a receptor for wastewater discharges and because monitoring of groundwater contaminated from INEL operations indicates contamination is generally below threshold levels of concentration. If concentrations are above threshold levels of concentration, appropriate treatment is performed.

Baseline air emission concentrations for hazardous/toxic air pollutants and their applicable standards are presented in section 4.2.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix section E.3.

Health impacts to INEL workers during normal operation may include those from: inhalation of the workplace atmosphere, drinking INEL potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are

protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. INEL workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 3790.1B) ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at INEL are expected to be substantially better than required by the standards.

**Health Effects Studies.** Two epidemiological studies have been conducted on the communities that surround INEL to determine if there are any excess cancers in the general population; no occupational epidemiological studies have been conducted at INEL to date. No excess cancer mortality was reported, although excess cancer incidence was observed. However, no association of the excess cancer incidence with INEL was established. For a more detailed description of the study findings reviewed, refer to appendix section E.4.2.

**Accident History.** A recent study was conducted by DOE *Idaho National Engineering Laboratory Historical Dose Evaluation* (DOE/ID-12119) to estimate the potential offsite radiation doses for the entire operating history of INEL. Releases resulted from a variety of tests and experiments as well as a few accidents at INEL. The study concluded that these releases have made a substantial contribution to the total radiation dose during test programs of the 1950's and early 1960's. The frequency and size of releases has declined since that time. Based on information reported in the study, there have been no serious unplanned or accidental releases of radioactivity or other hazardous substance at INEL facilities in the last 10 years of operation.

In the event of an accident, each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. Section 4.1.9 provides a description of DOE's emergency preparedness program.

Participating government agencies whose plans are interrelated with the INEL Emergency Plan for Action include the State of Idaho, Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, the Bureau of Indian Affairs, and Fort Hall Indian Reservation. INEL contractors are responsible for responding to emergencies that occur at their facilities. When an emergency condition exists at a contractor facility, the Emergency Action Director is responsible for recognition, classification, notifications, and protective action recommendations. At INEL, emergency preparedness resources include fire protection from onsite and offsite locations and radiological and hazardous chemical material response. Emergency response facilities include an emergency control center at each facility, the INEL warning communication center, and the INEL site emergency operations center. There are also seven INEL medical facilities available to provide routing and emergency service (INEL 1991a:2).

#### 4.2.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for INEL. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.1. Table 4.2.2.10–1 presents a summary of waste management activities at INEL for 1992.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at INEL. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

EPA placed INEL on the NPL on December 21, 1989. DOE has entered into a Federal Facility Agreement and Consent Order with EPA and the State of Idaho to coordinate cleanup activities at INEL under a comprehensive strategy. This

TABLE 4.2.2.10–1.—*Current Spent Nuclear Fuel and Waste Management at Idaho National Engineering Laboratory* [Page 1 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | 0.4 metric ton heavy metal[a] | Conditioning and stabilization | Under assessment[b] | Pools, dry facility | Under assessment[b] | None, federal repository in the future | None |
| **High-level** | | | | | | | |
| Liquid | 1,570 (317,059 gal) | Evaporation, calcination | 3,000 (606,000 GPY) | Tank farm, after evaporation prior to calcination | 17,500 (3,530,000 gal) | NA | NA |
| Solid[c] | None | Under development | Planned | Bins inside concrete vaults | 9,267 | None, federal repository in the future | None |
| **Transuranic** | | | | | | | |
| Liquid | None | NA | NA | NA | NA | NA | NA |
| Solid | 1 | Under development | Expandable as required | Asphalt pads and vaults in the ground or under earthen cover or tarps | Under assessment[b] | None, federal repository in the future | None |
| **Low-level** | | | | | | | |
| Liquid | None | Evaporation | 15,993 (3,230,365 GPY) | Tank farm after evaporation prior to calcination | Included in HLW | NA | NA |
| Solid | 14,757 | Incineration and compaction | 2,300 | NA | NA | Onsite burial | 235,345[d] |
| **Mixed** | | | | | | | |
| Liquid | 6.6 (1,341 gal) | Evaporation, fractionation, and calcination | 14,400 (2,900,000 GPY) | Tank farm | Included in HLW | None | None |
| Solid | 67 | Incineration and compaction[d] | 64,900 | Mixed waste and WERF storage facilities, radioactive sodium storage facilities | 2,300 | None | None |

TABLE 4.2.2.10–1.—*Current Spent Nuclear Fuel and Waste Management at Idaho National Engineering Laboratory* [Page 2 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Hazardous** | | | | | | | |
| Liquid | Included in solid | Offsite and percolation ponds | Under assessment[b] | Percolation ponds | Under assessment[b] | Offsite[f] | NA |
| Solid | 1,092[e] | Offsite | NA | Hazardous waste storage facility | Under assessment[b] | Offsite[f] | NA |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 66,446 (13,422,173 gal) | Percolation ponds | NA | NA | NA | NA | NA |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | Included in sanitary | Recycle | NA | NA | NA | NA | NA |
| Solid | 81,058 | Segregate and recycle | NA | NA | NA | Industrial and asbestos waste landfills | 2,400,000 to 4,000,000[g] |

[a] Does not include naval reactor fuel; data not available.

[b] Capacity being reevaluated as part of DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS.

[c] Solid HLW produced by calcination of liquid HLW.

[d] 48,000 $yd^3$ available as of 1991. Additional 88,000 $yd^3$ expansion capacity potentially available.

[e] 980 $yd^3$ recyclable.

[f] DOE has placed a moratorium on shipping any hazardous waste that could possibly be contaminated with radioactive components. The moratorium will not be lifted until procedures are in place to minimize liability posed by offsite disposal.

[g] Remaining capacity.

Note: WERF - Waste Experimental Reduction Facility; NA - not applicable.

Source: DOE 1992f; DOE 1993d; DOE 1993f; DOE 1994f; IN DOE 1992b; IN DOE 1992c; INEL 1993a:1; INEL 1993a:2; INEL 1993a:5.

agreement integrates DOE's CERCLA response obligations with RCRA and *Hazardous Waste Management Act* corrective action obligations. In this process, INEL has been divided into 10 waste area groups. Each group is subdivided into separate operable units which are groupings of potential release sites that are considered together for assessment and cleanup activities. Ongoing assessments are characterizing the nature and extent of contamination. Aggressive plans are in place to achieve early remediation of sites that represent the greatest risk to workers and the public. The goal is to complete remediation of contaminated sites at INEL to support delisting from the NPL by 2019.

INEL manages spent nuclear fuel and the following waste categories: high-level (HLW), transuranic (TRU), low-level (LLW), mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

**Spent Nuclear Fuel.** Spent nuclear fuel had been stored and processed at the Idaho Chemical Processing Plant. Processing was terminated with DOE's decision not to reprocess spent nuclear fuel to recover useful isotopes. INEL has received spent fuel from Three Mile Island, reactor tests, and the gas-cooled reactor and naval reactors programs. Spent nuclear fuel from these programs and from reactor experiments at INEL is in storage in various locations. The bulk of the fuel is stored at the Idaho Chemical Processing Plant. Interim management of the spent nuclear fuel (pending the availability of a geologic repository) will be in accordance with the Record of Decision (ROD) of the *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs EIS*, which DOE has published in draft form. The DOE sites other than INEL that are being evaluated as alternative locations for transporting, receiving, processing, and storing spent fuel include Hanford, NTS, ORR, and SRS.

**High-Level Waste.** HLW at INEL was generated in the process of extracting useful isotopes from spent nuclear fuel at the Idaho Chemical Processing Plant. Most of this fuel was from the naval reactors program. Most aqueous solutions from spent fuel processing and isotope extraction were concentrated by evaporation and separated into low-level and high-level waste streams in the Process Equipment Waste Evaporator. The liquid HLW is stored in subsurface tanks and then transformed into solid metallic oxides in a granular form by calcination. The majority of the waste in storage tanks contains sodium and cannot be calcined directly. New equipment is being installed to permit resumption of calcination in 1996. The calcine is stored in stainless steel bins in near-surface concrete vaults where it awaits further processing into a form suitable for emplacement in a Federal repository. Eventually, a facility will be built to convert the calcine into an immobilized form. Storage of new calcine, generated after May 1992, is prohibited by the RCRA-Land Disposal Restrictions. The Idaho Operations Office has prepared a No-Migration Variance Petition to be submitted to EPA for the continued storage of calcine. Calcination will continue and new storage facilities will be added as necessary until all the liquid HLW is stabilized.

**Transuranic Waste.** TRU wastes are stored at the Radioactive Waste Management Complex. The inventory represents more than half of the total DOE inventory. There is very little TRU waste generation at INEL. Most of the TRU waste in storage was received from the Rocky Flats Environmental Technology Site (formerly known as the Rocky Flats Plant), but shipments may be accepted on a case-by-case basis. Since 1989, there has been a moratorium on the receipt of TRU wastes from out-of-state facilities; TRU wastes are currently being stored pending the outcome of the Waste Isolation Pilot Plant (WIPP) Test Program to determine the suitability of WIPP to serve as a repository for these wastes. Assuming WIPP is determined to be a suitable repository for these wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, these wastes will be treated to meet the WIPP Waste Acceptance Criteria and packaged in accordance with DOE and NRC requirements for transport to WIPP for disposal.

Prior to 1970, when the Atomic Energy Commission required segregation of TRU wastes from other wastes, TRU wastes were buried in earthen trenches at the Radioactive Waste Management Complex. This waste must be retrieved and repackaged to meet the current WIPP Waste Acceptance Criteria. Wastes generated or received from offsite since 1970 are stored in a form designed for eventual retrieval. Since 1972, TRU wastes have been stored on Pad A in the Radioactive Waste Management Complex.

Most of this waste will require certification and repackaging. A new facility, the Idaho Waste Processing Facility, is being designed to accomplish this task. Some waste has radioactivity levels high enough that there are no certified or licensed transportation capabilities for it. Further study will be required for its eventual disposal. While the EPA has issued a notice of noncompliance for TRU waste stored at the Radioactive Waste Management Complex, a proposed plan for the treatment and storage of TRU wastes has been documented in the Federal Facility Agreement and Consent Order, which addresses EPA and State of Idaho concerns, while also meeting DOE's concerns for worker protection.

Most of the mixed TRU waste at INEL requires retrieval, treatment, and repackaging in order to meet the WIPP Waste Acceptance Criteria. Additional facilities at other areas of INEL are planned for the treatment of mixed waste, rendering it acceptable for disposal. The specifics of their site treatment plan will be detailed pursuant to the requirements of the *Federal Facility Compliance Act* and as negotiated with the State of Idaho and EPA. Some of the waste now handled as TRU or mixed TRU is alpha-contaminated LLW and mixed LLW. A strategy for treatment and disposal of this waste has yet to be established. Onsite and offsite treatment is being investigated.

**Low-Level Waste.** The bulk of LLW generated at INEL is the result of work in contaminated areas, and consists of materials such as rags, bags, scrap metal, and used protective clothing. A large volume of LLW is generated in the decontamination and decommissioning activities associated with environmental restoration. These materials must be treated by the operating facility to meet the waste acceptance criteria of the receiving facility, and their conformity to these criteria must be inspected by the receiving facility. Solid LLW at INEL is sent to the Waste Experimental Reduction Facility for compaction, sizing, incineration, and stabilization prior to shipment for disposal at the Radioactive Waste Management Complex. The Waste Experimental Reduction Facility, shut down while undergoing a revision of processes and procedures, is currently in startup and is expected to be in operation early in 1995.

**Mixed Low-Level Waste.** The volume of mixed waste generated at INEL is small. This mixed waste is stored in several areas onsite awaiting treatment capacities to be developed to treat the specific nature of a wide variety of different mixed waste streams. Organic mixed low-level wastes are planned to be processed through the Waste Experimental Reduction Facility incinerator to the established Land Disposal Restrictions treatment standards. The resulting ash will be immobilized and disposed of as LLW. The use of commercial treatment facilities is also being considered. Large volumes of wastewater are processed in the Process Equipment Waste Evaporator, resulting in a concentrated mixed waste that is sent to the HLW tank farm and eventually stabilized in a fluidized bed calciner. Condensate from the Process Equipment Waste Evaporator is converted into a concentrated acidic solution in the Liquid Effluent Treatment Facility. This concentrate is either recycled as a scrubber solution for the calciner or sent to the HLW tank farm for storage. The Liquid Effluent Treatment Facility eliminates residual discharge of hazardous/radioactive contaminants into wastewater percolation ponds, which was the former practice, in accordance with a consent order signed on October 7, 1992. The current mixed waste site treatment plans are undergoing review to ensure compliance with the *Federal Facility Compliance Act* of 1992. DOE has proposed to enter into a compliance agreement concerning the storage and continued generation of Land Disposal Restriction wastes until treatment methods are developed.

**Hazardous Waste.** Hazardous wastes are generated at the widely separated facilities at INEL and sent to the Hazardous Waste Storage Facility in the Central Facilities Area. There it is staged for shipment offsite to commercial RCRA-permitted treatment and disposal facilities. DOE has temporarily prohibited offsite shipments pending development of a system for the certification that the wastes have no radioactive content (are not mixed waste). The facilities for the storage of hazardous wastes are planned for expansion or replacement. New onsite facilities for treatment and disposal are also under study.

**Nonhazardous Waste.** Nonhazardous waste generated at INEL facilities is disposed of onsite in a landfill complex in the Central Facilities Area. The current landfill complex contains separate areas for sanitary, industrial, and asbestos waste. Sewage is

directed to surface impoundments in accordance with terms of the October 7, 1992, consent order, and the water is allowed to evaporate. The resulting sludge is placed in the landfill. Solids are separated and reclaimed where possible. The goal of the INEL waste minimization program is to reduce the nonhazardous waste quantities generated by 50 percent over the next 5 years. INEL has eliminated the commercial/industrial waste streams that had previously been generated and disposed of in the commercial/industrial landfill.

### 4.2.3 Environmental Impacts

This section describes the environmental impacts of constructing and operating various tritium supply technologies and recycling facilities at INEL, which are described in sections 3.4.2 and 3.4.3. The section begins by describing potential impacts to existing and planned facilities at INEL, followed by descriptions of potential impacts and the environmental impacts of the proposed alternatives on potentially affected environmental resources. The section concludes by describing the potential impacts of tritium supply and recycling on human health during normal operation, the consequences of facility accidents, and regulatory considerations and waste management. Each description addresses the effects of No Action and the potential impacts and environmental impacts of constructing and operating any of the tritium supply technologies and collocated recycling facilities or tritium supply facilities alone at INEL.

#### 4.2.3.1 *Land Resources*

Construction and operation of tritium supply and recycling facilities at INEL would affect land resources, including land use and visual resources. Potential impacts to these resources are summarized below.

INEL has sufficient land area to accommodate any of the proposed tritium supply technologies and collocated recycling facilities or tritium supply facilities alone. These facilities would be located within the designated 600-acre TSS. The construction and operation of any of the facilities would be consistent with the external views of INEL. The following sections present the effects of proposed alternatives on land resources.

**Land Use.**

*No Action.* Under No Action, no additional land use impacts are anticipated at INEL beyond the effects of existing and future activities that are independent of the proposed action.

*Tritium Supply and Recycling.* Any one of the tritium supply technologies, and collocated tritium recycling facilities (section 3.4), or tritium supply facilities alone could be sited within the proposed TSS. Land requirements for the tritium facilities are presented in table 4.2.3.1–1. The land area affected ranges from 360 acres for the MHTGR to 173 acres for the APT. An additional 196 acres would be required if the tritium supply facility was collocated with a new recycling facility. Construction and operation of the tritium facilities would be consistent with the INEL Landlord Site Development Plan, and would not affect prime farmland, grazing allotments, other agricultural activities, or other land uses on the site.

No tritium facilities would be constructed offsite, and offsite land use would not be directly affected. Offsite undeveloped land is available and could be converted to residential developments to house workers. Such development would be subject to local land use controls and zoning ordinances, which vary by jurisdiction.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced capacity to meet a tritium supply requirement less than baseline,

**TABLE 4.2.3.1–1.—*Potential Changes to Land Use Resulting from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory***

| | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|
| **Indicator** | **HWR** | **MHTGR** | **ALWR[a]** | **APT[b]** | **Tritium Recycling** |
| Land requirements[c] (acres) | 260 | 360 | 350 | 173 | 196 |
| Available land[d,e] (percent) | 0.05 | 0.06 | 0.06 | 0.03 | 0.04 |

[a] Land requirements for both Large and Small ALWR are the same.
[b] Land requirements for both Full and Phased APT are the same.
[c] Land area requirements are estimated to be the same for construction and operation.
[d] Undeveloped land is approximately 559,000 acres.
[e] Any land requirement less than 100 percent means sufficient land.
Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a.

or the construction and operation of a Phased APT would not change potential baseline tritium requirement land use impacts described above. Land requirements would be the same in both operation scenarios.

*Potential Mitigation Measures.* No mitigation measures are proposed.

**Visual Resources.**

*No Action.* Under No Action, the existing landscape character would remain unchanged, with a VRM classification of Class 4 (industrial use).

*Tritium Supply and Recycling.* The construction and operation of either the proposed tritium supply and recycling facilities or the tritium supply facilities alone would be consistent with the existing views of INEL, which consist of large industrial facilities and plumes from cooling towers. The existing Class 4 industrial use landscape character would remain unchanged. The proposed facilities, except for the APT which is mostly low profile structures, would be visible in the background (approximately 7 miles away) with the existing INEL facilities from the Lost River State Rest Area along U.S. Route 20/26. Impacts would be negligible. The impacts of the tritium supply technologies and recycling facilities on the Environmental Breeder Reactor I National Historic Landmark would be similar to the Lost River State Rest Area. Impacts to the view from Black Canyon Wilderness Study Area, approximately 16 miles away, would be less than the previously mentioned viewpoints because of greater distance. The Craters of the Moon National Monument, located 37 miles away from the proposed TSS, would also incur virtually no visual impacts because of greater distance. Because a non-evaporative cooling system is proposed for reactor technologies at INEL, there would be little visual impact from plumes.

*Less Than Baseline Operations.* Baseline requirement visual impacts would not change due to operation of the HWR, MHTGR or ALWR at reduced capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* No mitigation measures are proposed.

#### 4.2.3.2 *Site Infrastructure*

This section discusses the site infrastructure for No Action and the modifications needed for actions due to construction and operation of new tritium supply and recycling facilities. Construction and operation of each alternative at INEL would affect the site infrastructure in varying degrees, depending upon the specific tritium supply technology chosen. All of the tritium supply technologies would require major modifications to the electrical power infrastructure at the site. A comparison of the site infrastructure and facility resource needs for No Action and the proposed tritium supply alternatives is presented in table 4.2.3.2–1.

**No Action.** Missions discussed in section 3.3.2 would continue under No Action. There are no defense program activities being performed at INEL, and none are being considered other than tritium supply; therefore, under No Action, there would be no impacts to INEL.

**Tritium Supply and Recycling.** The modifications to the infrastructure at INEL to support the various tritium supply technologies are summarized in table 4.2.3.2–1. The additional peak electrical power loads added to the No Action case for the various alternatives range from 62 MWe to 566 MWe (table 4.2.3.2–2). All the tritium supply alternatives would require additional power that could be supplied by the Northwest Regional Power Pool through the Idaho Power Company. The alternatives would utilize between 0.45 and 4.15 percent of the regional power pool capacity margin. In all cases, approximately 6 miles of connecting transmission lines from the Central Facilities Area would be required to provide power to the TSS. Some of the tritium supply and recycling facilities use natural gas as a primary fuel source. Currently, INEL does not use natural gas; therefore, the equivalent amount of fuel oil was used to determine fuel impacts where natural gas is used.

In order to connect the TSS with the INEL road network, approximately 8 miles of additional primary and secondary access roads would be required and a small railroad spur, approximately 2 miles, may be necessary to support new tritium supply and recycling facilities transportation requirements. The APT would require an additional 3 miles of access

TABLE 4.2.3.2–1.—*Modifications to Site Infrastructure for Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory*

| Alternative | Transportation | | Electrical | | Fuel | | |
|---|---|---|---|---|---|---|---|
| | Road (miles) | Railroad (miles) | Energy (MWh/yr) | Peak Load (MWe) | Oil (GPY)[a] | Natural Gas (million $ft^3$/yr) | Coal (tons/yr) |
| **Current Resources** | 277 | 30 | 232,500 | 93 | 1,538,800 | 0 | 12,500 |
| **No Action** | | | | | | | |
| Total site requirement | 277 | 30 | 232,500 | 42 | 1,538,800 | 0 | 12,500 |
| Change from current resources | 0 | 0 | 0 | -51 | 0 | 0 | 0 |
| **Heavy Water Reactor** | | | | | | | |
| Total site requirement | 285 | 32 | 860,500 | 127 | 3,295,000 | 0 | 20,300 |
| Change from current resources | 8 | 2 | 628,000 | 34 | 1,757,000 | 0 | 0 |
| **Modular High Temperature Gas-Cooled Reactor** | | | | | | | |
| Total site requirement | 285 | 32 | 680,500 | 104 | 1,754,500 | 0 | 12,500 |
| Change from current resources | 8 | 2 | 448,000 | 11 | 216,500 | 0 | 0 |
| **Large Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 285 | 32 | 1,420,500 | 198 | 1,834,000 | 0 | 12,500 |
| Change from current resources | 8 | 2 | 1,188,000 | 105 | 296,000 | 0 | 0 |
| **Small Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 285 | 32 | 900,500 | 133 | 1,744,000 | 0 | 12,500 |
| Change from current resources | 8 | 2 | 668,000 | 40 | 206,000 | 0 | 0 |
| **Full Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 288 | 32 | 4,060,500 | 608 | 1,647,200 | 0 | 12,500 |
| Change from current resources | 11 | 2 | 3,828,000 | 515 | 109,200 | 0 | 0 |
| **Phased Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 288 | 32 | 2,720,500 | 413 | 1,647,200 | 0 | 12,500 |
| Change from current resources | 11 | 2 | 2,488,000 | 320 | 109,200 | 0 | 0 |

[a] Oil is the primary utility fuel at INEL and all natural gas requirements have been converted to an oil equivalent; natural gas is assumed to be 1,000 British thermal units per $ft^3$, and fuel oil (8lb/gal) is assumed to be 19,000 British thermal units per pound.

Note: A negative number (-) indicates that sufficient resources exist to meet the demands.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; INEL 1993a:5.

**TABLE 4.2.3.2–2.—*Impacts on Regional Electrical Power Pools from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory***

| Tritium Supply Technology and Recycling | Peak Power Required (MWe) | Capacity Margin (percent) | Annual Energy Required (MWh) | Total Electricity Production (percent) |
|---|---|---|---|---|
| Heavy Water Reactor | 85 | 0.62 | 628,000 | 0.25 |
| Modular High Temperature Gas-Cooled Reactor | 62 | 0.45 | 448,000 | 0.18 |
| Large Advanced Light Water Reactor | 156 | 1.14 | 1,188,000 | 0.46 |
| Small Advanced Light Water Reactor | 91 | 0.67 | 668,000 | 0.26 |
| Full Accelerator Production of Tritium | 566 | 4.15 | 3,828,000 | 1.49 |
| Phased Accelerator Production of Tritium | 371 | 2.72 | 2,488,000 | 0.97 |

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; INEL 1993a:5.

road. Interconnection requirements for facilities with the TSS are not expected to change appreciably when specific site adaptations are completed.

**Tritium Supply Only.** If new tritium recycling facilities were not collocated with the tritium supply facilities at INEL, and the upgraded recycling facilities at SRS were utilized, the overall impact at INEL would be reduced. Onsite transportation network and electrical transmission line requirements would not be affected. The electrical power requirements associated with each of the technologies would decrease by 88,000 MWh per year, with the peak load decreasing by 16 MWe. This represents a reduction in the total site peak power requirement of between 2 and 15 percent with no appreciable change to the capacity margin of the regional power pool. Even with these reductions, additional power would still be required from the Northwest Regional Power Pool through the Idaho Power Company, but the impact would be marginally less than previously discussed. The fuel oil requirement, which is primarily for heating, ventilation and air conditioning of the recycling facility, would decrease by approximately 96,000 gal per year.

**Less than Baseline Operations.** In the event that only the steady state component of the baseline tritium requirement is required, the impacts on the site infrastructure would change for some technologies. There would be no appreciable change for the HWR, MHTGR, and the ALWR technologies. The Phased APT would reduce electrical consumption by approximately 35 percent but the fuel, onsite transportation infrastructure, and power line requirements would not change.

**Potential Mitigation Measures.** Siting of new roads, railroad spurs, and utility infrastructure could follow existing rights-of-way to minimize impacts to natural resources. Where new rights-of-way would need to be constructed, alignments should consider existing sensitive habitat (e.g., wetlands, streams, and vegetation) to minimize the potential for impacting these resources.

### 4.2.3.3 *Air Quality and Acoustics*

Construction and operation of a tritium supply and recycling facility at INEL would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. To determine the air quality impacts, criteria and toxic/hazardous concentrations from each technology have been compared with Federal and state standards and guidelines. Impacts for radiological airborne emissions are discussed in section 4.2.3.9.

In general, all of the proposed technologies would emit the same types of air pollutants during construction. Emissions would typically not exceed Federal, state, or local air quality regulations or guidelines, except that $PM_{10}$ and TSP concentrations may be close to or exceed the 24-hour $PM_{10}$ and TSP standard during peak construction periods, which is not uncommon for large construction projects.

During operation, impacts from each of the individual tritium supply and recycling technologies with respect to the concentrations of criteria and toxic/hazardous air pollutants are predicted to be in compliance with Federal, state, and local air quality regulations or guidelines. The estimated pollutant concentrations presented in table 4.2.3.3–1 for each of the tritium supply technologies and recycling

**TABLE 4.2.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Idaho National Engineering Laboratory***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling (μg/m³) |
| **Criteria Pollutant** | | | | | | | | |
| Carbon monoxide (CO) | 8-hour | 10,000 | 6 | 38 | 113 | 46 | 18 | 12 |
| | 1-hour | 40,000 | 21 | 119 | 354 | 145 | 59 | 38 |
| Lead (Pb) | Calendar Quarter | 1.5 | c | c | c | c | c | c |
| Nitrogen dioxide ($NO_2$) | Annual | 100 | 8 | 9 | 11 | 11 | 8 | 0.4 |
| Ozone ($O_3$) | 1-hour | 235 | c | c | c | c | c | c |
| Particulate matter ($PM_{10}$)[a] | Annual | 50 | 14 | 14 | 14 | 14 | 14 | 0.1 |
| | 24-hour | 150 | 35 | 38 | 36 | 37 | 36 | 1.5 |
| Sulfur dioxide ($SO_2$) | Annual | 80 | 4 | 4 | 4 | 4 | 4 | 0.01 |
| | 24-hour | 365 | 46 | 46 | 46 | 47 | 46 | 0.1 |
| | 3-hour | 1,300 | 134 | 135 | 135 | 137 | 134 | 0.4 |
| **Mandated by Idaho** | | | | | | | | |
| Total suspended particulates (TSP)[a] | Annual | 60 | 40 | 40 | 40 | 40 | 40 | 0.1 |
| | 24-hour | 150 | 91 | 94 | 93 | 93 | 92 | 1.5 |
| **Hazardous and Other Toxic Compounds** | | | | | | | | |
| Acetone | 8-hour | 17,800 | 0.3 | 0.3 | 0.3 | 5.8 | 0.3 | c |
| Acetylene | 8-hour | b | c | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| Ammonia | 8-hour | 180 | 30 | 30 | 30 | 32.9 | 30 | c |
| Ethyl alcohol | 8-hour | 18,800 | c | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Methane | 8-hour | b | c | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| Methyl alcohol | 8-hour | 2,600 | c | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Nitric acid | 8-hour | 50 | 10 | 13.3 | 10 | 48.4 | 10 | c |
| 1,1,1-Trichloroethane | 8-hour | 19,100 | 0.2 | 0.8 | 0.4 | 12.8 | 0.2 | c |
| Trichlorotrifluoroethane | 8-hour | 76,700 | c | 23.3 | c | c | c | c |

[a] It is conservatively assumed that all $PM_{10}$ concentrations are TSP concentrations.

[b] There is no standard.

[c] No sources indicated.

Note: Concentrations for tritium supply and recycling include 2010 No Action concentrations. To determine the concentration of pollutants from each tritium supply technology, subtract the pollutant concentration for tritium recycling from each of the tritium supply and recycling concentrations.

Note: DOE is committed to the phaseout of ozone-depleting substances and will discontinue use of these substances according to EPA phaseout schedules.

Source: DOE 1992h; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN DHW 1992b.

facilities indicate little difference between technologies with respect to impacts to air quality.

The Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on the emission rates presented in appendix table B.1.4–1, Prevention of Significant Deterioration permits may be required for each of the proposed alternatives at INEL. This may require "offsets," reductions of existing emissions, to permit any additional or new emission source.

Noise emissions during either construction or operation are expected to be low. Air quality and acoustic impacts for each technology are described separately. Supporting data for the air quality and acoustics analysis, including modeling inputs, are presented in appendix B.

**Air Quality**. An analysis was conducted of the potential air quality impacts of emissions from each of the tritium supply technologies and recycling facilities. The air quality modeling analysis used the Industrial Source Complex Short-Term model recommended by EPA. The resulting air quality conditions were then evaluated against local and state air quality regulations, and NAAQS (40 CFR 50). The potential exceedance of Prevention of Significant Deterioration (40 CFR 52.21) increments for $PM_{10}$, $SO_2$, or $NO_2$ was also determined.

*No Action*. No Action utilizes estimated air emissions data from operations at INEL in the year 2010 assuming continuation of site missions as described in section 3.3.1. These data reflect conservative estimates of criteria and toxic/hazardous emissions at INEL. The emission rates for the criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.1.4–1. Table 4.2.3.3–1 presents the No Action concentrations. Pollutant concentrations are in compliance with all air quality regulations and guidelines. It is conservatively assumed that $PM_{10}$ concentrations are equal to TSP concentrations.

*Tritium Supply and Recycling*. Alternatives for INEL consist of four candidate technologies: HWR, MHTGR, ALWR and APT, alone and collocated with tritium recycling facilities. Air pollutants would be emitted during construction of the tritium supply and recycling facilities. The principal sources of such emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant.

- Exhaust from, and road dust raised by, construction equipment, vehicles delivering construction material, and vehicles carrying construction workers.

$PM_{10}$ and TSP concentrations are expected to be close to or exceed the 24-hour ambient standard during the peak construction period. Exceedances would also be expected to occur during dry and windy conditions. Appropriate control measures would be followed, such as watering to reduce emissions. With the exception of $PM_{10}$ and TSP, it is expected that concentrations of all other pollutants at the INEL boundary or public access highways would remain within applicable Federal and state ambient air quality standards during construction.

Air pollutant emission sources associated with the operation of each of the technologies include all or part of the following:

- Increased operation of existing boilers to generate additional steam for space heating.

- Operation of diesel generators and periodic testing of emergency diesel generators.

- Recycling operations.

- Exhaust from, and road dust raised by, vehicles delivering supplies and bringing employees to work.

Appendix table B.1.4–1 presents emissions from each of the proposed tritium supply technologies and recycling facilities. There are no gaseous releases associated with the APT (SNL 1995a), although emissions are associated with operation of the tritium supply facility included with the APT and with recycling facilities. Emissions from the Large

ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Consequences from operation of the tritium supply and recycling facilities at INEL are presented in table 4.2.3.3–1. Pollutant concentrations, combined with the No Action concentrations, are in compliance with Federal and state standards.

Pollutant emissions resulting from the operation of tritium supply technologies alone (HWR, MHTGR, ALWR and APT) consist of criteria pollutants from the operation of boilers and diesel generators and toxic/hazardous pollutant emissions from facility processes. Criteria pollutant emissions from the MHTGR are the highest among the other tritium supply technologies and would increase existing total site criteria pollutant emissions by less than 5 percent above No Action emissions. Concentrations of criteria and toxic/hazardous pollutants, added to No Action concentrations, are in compliance with Federal and state standards.

*Less Than Baseline Operations.* Air emissions from the HWR would be reduced slightly when operated at reduced capacity. However, the reduction would be negligible since most emissions are attributed to support equipment and facilities that are not related to the reactor operating level. The MHTGR or ALWR would have no change in air emissions because it would continue to operate at the same level as the baseline requirement to maintain power levels for steam or electrical production. The Phased APT construction and operation emissions and impacts would be the same as the Full APT.

*Potential Mitigation Measures.* Potential mitigation measures during construction include: watering to reduce dust emissions; applying non-toxic soil stabilizers to all inactive construction areas; covering, watering, or applying non-toxic soil binders to exposed piles (i.e., gravel, sand, dirt); suspending all excavation and grading operations when wind speeds warrant; paving construction roads that have a traffic volume of more than 50 daily trips by construction equipment; and using electricity from power poles rather than temporary gasoline and diesel power generators. Potential mitigation measures during operation include incorporating additional HEPA filters to reduce particulate emissions from processing facilities; substituting cleaning solvents for those which present health hazards or exceed the applicable standards; and switching from coal or fuel oil, to produce electricity or steam, to natural gas to reduce criteria pollutants.

**Acoustics.** The location of the tritium supply technologies and recycling facilities relative to the site boundary and sensitive receptors was examined to determine the contribution to noise levels at these locations and the potential for onsite and offsite impacts.

*No Action.* The continuation of operations at INEL would result in no appreciable change in traffic noise and onsite operational noise sources from current levels (section 4.2.2.3). Sources of non-traffic noise associated with current operations are located at sufficient distances from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

*Tritium Supply and Recycling.* Noise sources during construction may include heavy-construction equipment and increased traffic. Increased traffic would occur onsite and along offsite major transportation routes used to bring construction material and workers to the site.

Most non-traffic noise sources associated with operation of tritium supply and recycling facilities would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would continue to be small. Due to the size of the site, noise emissions from construction equipment and operations activities would not be expected to cause annoyance to the public.

Noise impacts associated with increased traffic on access routes would be considered in tiered NEPA documents. Some non-traffic noise sources associated with construction and operation of the tritium supply technologies and recycling facilities may be located close enough to offsite noise receptors that they could experience some increase in noise levels.

*Less Than Baseline Operations.* Baseline noise impacts would not change due to reactors operating at reduced tritium capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Potential measures to minimize noise impacts on workers include the use

of standard silencing packages on construction equipment and providing workers in noisy environments with appropriate hearing protection devices meeting OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

#### 4.2.3.4 *Water Resources*

Environmental impacts associated with the construction and operation of the proposed tritium supply technologies and recycling facilities at INEL would affect surface water and groundwater resources. No surface water would be withdrawn for construction or from normal operations. Instead, groundwater from the Snake River Plain aquifer would be used, which is a sufficient source. Water requirements for normal operation for all tritium supply technologies would fall within INEL's current allotment. The site proposed for the tritium supply and recycling facilities would be outside the floodplain that could result from failure of McKay Dam during a probable maximum flood. During construction, treated sanitary wastewater would be discharged to lined evaporation ponds. While the potential impacts to surface waters during the construction phase would be erosion and sedimentation of drainage channels, the relatively dry climate and application of appropriate controls should preclude adverse impacts. No wastewater would be discharged to surface waters during operation of tritium supply and recycling facilities, nor would there be impacts to surface water quality from these types of activities. All wastewater would be treated and either recycled for cooling system makeup or discharged to lined evaporation ponds. Stormwater runoff would be collected and treated if necessary before discharge to natural drainage channels.

Table 4.2.3.4–1 presents existing surface water and groundwater resources and the potential changes to water resources at INEL resulting from the proposed tritium supply technologies and recycling facilities. Resource requirements for each tritium supply technology shown in this table represent the total requirements at the site, including No Action. Resource requirements for tritium recycling are added to these values to obtain the water resource requirements for assessing impacts associated with combined tritium supply and recycling.

**Surface Water.**

*No Action.* Under No Action, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities that are independent of and unaffected by the proposed action. A description of the activities that would continue at INEL is provided in section 3.3.2.

*Tritium Supply and Recycling.* No surface water would be withdrawn for any construction or operation activities associated with any of the tritium supply technologies and recycling facilities; consequently, no impacts to surface water availability or surface water quality are expected. The potential impacts to surface waters during the construction phase would be erosion of disturbed land and sedimentation in drainage channels. To minimize soil erosion impacts, stormwater management and standard erosion control measures would be employed. In most cases, impacts from runoff would be temporary and manageable. Nonhazardous wastewater, including sanitary wastewater, generated during the construction of either the collocated tritium supply and recycling facilities (which ranges from 1.2 MGY for the APT to 28.4 MGY for the Large ALWR) or the tritium supply facilities alone (which ranges from 0.3 MGY for the APT and 27.5 MGY for the Large ALWR) would be discharged to either a leach field or lined evaporation ponds.

During operation, no effluents would be discharged to natural surface waters. Utility, process and sanitary wastewater from HWR, MHTGR, or ALWR would be treated prior to discharge into lined evaporation ponds. However, cooling system blowdown and sanitary wastewater from APT would be treated and recycled for reuse as cooling system makeup. The treated effluent from the process wastewater treatment would be discharged to lined evaporation ponds. Treated effluent would be monitored to comply with the NPDES permit and other discharge requirements. The extent to which treated effluents or stormwaters would be recycled for reuse within the plant would be determined during site-specific studies.

Stormwater runoff from either the collocated tritium supply and recycling facilities or the tritium supply facility alone would be collected in detention ponds. Runoff from site support facilities outside the main

**TABLE 4.2.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory***

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | Tritium Recycling[b] |
| | | | | Large | Small | Full | Phased | |
| **Construction** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total water requirement (MGY)[c] | 2,000 | 2,021 | 2,018 | 2,033 | 2,020 | 2,008 | 2,010 | 1.5 |
| Percent increase in projected water use (2,000 MGY) | 0 | 1 | 1 | 2 | 1 | <1 | <1 | NA |
| Percent of groundwater allotment (11,360 MGY) | 18 | 18 | 18 | 18 | 18 | 18 | 18 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to surface waters or groundwater (MGY) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percent change in stream flow from wastewater | NA | NA | NA | NA | NA | NA | NA | NA |
| NPDES permit required[d] | NA | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| **Operation** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total water requirement (MGY)[e] | 2,000 | 2,048 | 2,030 | 2,090 | 2,050 | 4,642 | 3,691 | 14 |
| Percent increase in projected water use (2,000 MGY) | 0 | 2 | 2 | 5 | 3 | 132 | 85 | NA |
| Percent of groundwater allotment (11,360 MGY) | 18 | 18 | 18 | 18 | 18 | 41 | 32 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to surface waters or groundwater (MGY) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percent change in stream flow from wastewater | NA | NA | NA | NA | NA | NA | NA | NA |
| NPDES permit required[d] | No | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| **Floodplain** | | | | | | | | |
| Actions in 100-year floodplain | NA | No | No | No | No | No | No | NA |
| Critical actions in 500-year floodplain | NA | No | No | No | No | No | No | NA |
| Floodplain assessment required | NA | No | No | No | No | No | No | NA |

[a] Operational water requirements for MHTGR and ALWR include utilization of steam turbine generators.
[b] Resource requirements for tritium recycling do not include No Action. The values presented in this column are added to the requirements for each tritium supply technology to assess the impacts associated with combined tritium supply and recycling.
[c] Total water requirements for construction at INEL are calculated by adding baseline requirements (2,000 MGY) with that for each tritium supply technology: HWR (21 MGY), MHTGR (18 MGY), ALWR (33 MGY for Large and 20 MGY for Small), and APT (8.3 MGY).
[d] NPDES permit is required for stormwater discharges.
[e] Total water requirements for operation at INEL are calculated by adding baseline requirements (2,000 MGY) with that for each tritium supply technology: HWR (48 MGY), MHTGR (30 MGY), APT (1,691 MGY for Phased and 2,642 MGY for Full), and ALWR (90 MGY for Large and 50 MGY for Small).
Note: NA - not applicable.
Note: Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.
Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; INEL 1993a:5; SR DOE 1995a.

facility, except those that require onsite management measures by regulation such as sanitary wastewater plants and landfill areas, would be discharged directly to natural drainage channels. Uncontaminated stormwater runoff would be released to natural drainage channels, while contaminated stormwater runoff would be retained, treated in the radioactive waste treatment system, and released. All stormwater discharges to natural channels would be subject to compliance with NPDES permit requirements.

The site proposed for construction of the tritium supply facility is outside the flood zone of the Big Lost River that could develop as a result of the failure of MacKay Dam during a probable maximum flood. This flood event would be more critical than either the 100- or 500-year flood. The 1-mile buffer zone between the boundary of the proposed site and the location of the new facilities would provide an additional measure of flood protection. Where a potential exists for flooding impacts, design mitigation measures will be considered and discussed in site-specific tiered NEPA documents.

*Less Than Baseline Operations.* Baseline tritium requirement surface water impacts described above for the construction and operation phases would not change due to changes in the reactor operating capacity, or construction and operation of a Phased APT.

*Potential Mitigation Measures.* No mitigation measures in addition to those implemented during construction to comply with the NPDES stormwater regulations have been identified. Stormwater measures include stabilization practices that cover soils with materials such as vegetation, riprap, or mulch in order to prevent direct exposure of soils to runoff, and structural controls, such as silt fences, dikes, and sediment traps, that divert runoff away from disturbed areas. The dry climate and application of management measures should preclude potential adverse impacts during operation from stormwater runoff. Similarly, during operation, releases of stormwater runoff would be monitored and subject to NPDES regulations.

**Groundwater.**

*No Action.* Under No Action, no additional impacts to groundwater resources are anticipated beyond the effects of existing and future activities that are independent of and unaffected by the proposed action.

**Groundwater Availability and Use.**

*Tritium Supply and Recycling.* Groundwater required for construction of either a collocated tritium supply and recycling facility or a tritium supply facility alone would represent approximately a 2-percent maximum increase over the projected groundwater withdrawal, and would be approximately 18 percent of INEL's current allotment. Thus no additional allotments or permits would be required and it would not cause depletion of the aquifer or affect recharge. Groundwater required for both construction and operation of the tritium supply technologies and recycling facilities and the percent increase in projected water use are shown in table 4.2.3.4–1. As discussed in section 4.2.2.4, a groundwater allotment, not to exceed 11,360 MGY, has been negotiated by DOE with the Idaho Department of Water Resources under the Federal Reserve Doctrine. Additionally, 35,386 MGY of water statewide could be available for non-farm development under the Idaho-Swan Falls agreement (INEL 1993a:5). As shown in table 4.2.3.4–1, operating an HWR, MHTGR, ALWR, or APT, whether collocated with recycling facilities or alone, would not exceed current groundwater allotments.

Previous studies, using a steady-state model of groundwater withdrawals of up to 7,300 MGY from wells located in the area of the proposed TSS, have estimated that for a continuous pumping well drawdowns in the unconfined aquifer at the well would be approximately 13 feet (5 percent of saturated thickness in this area). At a distance of 984 feet from the pumping area, drawdowns would be approximately 12 feet whereas at the INEL southern boundary, the drawdown would be approximately 3.6 feet. Recharge studies indicate that it would take approximately 10 years for offsite springs near Hagerman, Idaho to show signs of decline caused by pumping. Other studies indicate that pumping at a rate of 11,624 MGY for 50 years would cause a decline in the water table near the springs of less than one foot.

In comparison, operation of an HWR, MHTGR, ALWR or APT, would use less water than the groundwater withdrawals used in the model

discussed above and no impacts on recharge or to nearby springs are anticipated.

*Less Than Baseline Operations.* Operation of the HWR at reduced capacity to meet a tritium supply requirement less than baseline would not change the operating water requirements or the quantity of water discharges. The MHTGR or ALWR water requirements and discharges would not change from the baseline; therefore, the potential impacts would remain the same.

Construction of the Phased APT would require 2,010 MGY, an increase of 2 MGY over that required by the Full APT (table 4.2.3.4-1). The construction water requirement of the Phased APT represents an increase of less than one percent over projected No Action water use. Operation of the Phased APT would require 3,691 MGY, an 85-percent increase over projected No Action water use. This is approximately two thirds of the 132-percent increase required by the Full APT. The additional 3,691 MGY would not exceed current groundwater allotments. All other requirements of the Phased APT are identical to those of the Full APT.

**Groundwater Quality.**

*Tritium Supply and Recycling.* During construction, no water would be discharged directly to the environment and thus would not affect groundwater quality. During operation, treated utility, process, and sanitary wastewater would be treated and discharged to evaporation ponds. Therefore, no impacts to groundwater quality would be anticipated.

Existing tritium plumes in groundwater and in perched groundwater south of the proposed tritium facilities are expected to continue to migrate southwesterly, away from the proposed TSS. Studies showed that water withdrawals could change the existing plumes' southwesterly direction to the east, but would not draw the plume into the proposed TSS.

*Less Than Baseline Operations.* Potential groundwater quality impacts described above would not change due to changes in reactor operating capacities, or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Potential groundwater withdrawals could influence existing southwesterly direction of the tritium plume to the east. Mitigation measures to protect drinking water sources in the vicinity of the affected aquifer could include a monitoring well program to detect changes in contaminate direction or rate of movement, the deepening of existing walls, or the drilling of new wells.

#### 4.2.3.5 *Geology and Soils*

Construction of tritium supply and recycling facilities at INEL would have no impact on geological resources described in section 4.2.2.5. A moderately low seismic risk exists, which would be considered in the design of the structures. The existing seismic risk does not preclude safe construction and operation of the facilities. The only other geological hazard present is volcanic activity, which is improbable and is not anticipated to impact the project. Construction would disturb up to a few hundred surface acres of soil, the amount depending on the tritium supply technology and recycling facilities. Control measures would be used to minimize soil erosion. Impacts would depend on the specific soil units in the disturbed area, the extent of land disturbing activities, and the amount of soil disturbed. Potential changes to geology and soils associated with the construction and operation of tritium supply and recycling facilities at INEL are discussed below.

**No Action.** Under No Action, DOE would continue existing and planned activities at INEL. Any impacts to geology and soils from these actions would be independent of and unaffected by the proposed action.

**Tritium Supply and Recycling.** Construction activities would not affect geological conditions. Design of the facilities would ensure that they would not be adversely affected by geological conditions.

Because there are no known capable faults at or near the proposed TSS, there is little potential for ground rupture as a result of an earthquake during the life of the tritium facilities. Ground shaking is more likely. Intensities of approximately VII on the modified Mercalli scale are possible at INEL which would not affect newly designed facilities. Based on the seismic history of the area, a moderately low seismic

risk exists at INEL which should not preclude safe construction and operation of the facilities. In addition, facilities would be designed for earthquake-generated ground accelerations in accordance with DOE Order 5480.28 and accompanying safety guides.

Although there is a history of volcanism in the INEL area, explosive volcanic eruptions are improbable (section 4.2.2.5). Lava extrusion could recur with recurrence probabilities at about once in every 3,000 years. Precursors, such as shallow earthquakes, gas venting activity, and increase in groundwater temperatures provide advance warning of most eruptions of this type; no such activity is currently indicated at INEL.

It is highly unlikely that landslides, sinkhole development, or other nontectonic events would affect project activities. Slopes and underlying foundation materials are stable. Potential health impacts from accidents associated with geological hazards are discussed in section 4.2.3.9.

Properties and conditions of the soils underlying the proposed site have no limitations on construction. Soils, therefore, would not adversely affect the safe operation of the facilities. Soils would be impacted by construction and operation of the facilities. The amount of acreage that would be potentially disturbed by the tritium supply technologies and tritium recycling facilities is shown in table 4.2.3.1–1.

The soil disturbance from construction of new facilities would be as much as 562 acres for a MHTGR collocated with recycling facilities. Disturbance would occur at building, parking, and construction laydown areas, destroying the soil profile and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and, particularly during the construction period, the duration of time the soil is bare. Construction of both the MHTGR and the APT would also necessitate deep excavations to accommodate reactor modules and an accelerator tunnel, respectively (sections 3.4.2.2 and 3.4.2.4). A considerable volume of soil would be removed as a result of excavations. Most of the material removed would be basaltic bedrock and could be stockpiled for use as fill. Some of this material could be used to cover the accelerator tunnel of the APT. Site-specific NEPA studies would evaluate in detail impacts to geology and soils at INEL resulting from deep excavations required for the MHTGR and the APT and would identify appropriate mitigation measures.

Net soil disturbance during operation would be less than for construction, because areas temporarily used for laydown would be restored. Although erosion from stormwater runoff and wind action could occur occasionally during operation, they are anticipated to be minimal.

Appropriate erosion and sediment control measures would be used to minimize soil loss. Wind erosion is likely to occur on an intermittent basis, depending on the wind velocities, the amount of soil exposed, and the effectiveness of control measures.

**Less Than Baseline Operations.** Under the less than baseline tritium requirement operation, geology and soil impacts would not change for the HWR, MHTGR or ALWR technologies. Disturbed acreage for the Phased APT would be the same as the Full APT; therefore, impacts would be the same.

**Potential Mitigation Measures.** Mitigation measures would be required to control erosion from exposed areas of soil during construction. Potential mitigation measures include accepted standard practices for erosion, sediment, and dust control from construction sites such as silt fences, sediment traps, runoff diversion dikes, drainageways, sedimentation ponds, establishment of ground cover and windbreaks, grading of slopes, construction of berms and drainageways, or other controls appropriate to the sites. Standard control for wind erosion, such as wetting the surface, would be done on a day-to-day basis. Exposing only small areas for limited periods of time, as necessary, could also reduce erosional effects. After the construction period, long-term control measures could include grading, revegetation, or landscaping.

#### 4.2.3.6 *Biotic Resources*

Construction and operation of tritium supply technology and recycling facilities at INEL would affect

biotic resources. Impacts resulting from the construction of the HWR, MHTGR, ALWR, or Full APT to meet the baseline tritium requirement would occur only at the beginning of the project life cycle. The less than baseline tritium requirement and Phased APT could incur some additional construction-related impacts if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion would occur in the already developed main plant site. Impacts to terrestrial resources would result from the loss of habitat during construction and operation. Impacts to wetlands and aquatic resources would not occur since these resources are not located on the proposed TSS. No Federal-listed threatened or endangered species would be affected by the proposed action. Several special-status species could be affected, primarily through the loss of potential foraging habitat. However, the viability of populations of these species is not likely to be impacted. Where potential conflicts could occur, mitigation measures would be developed in consultation with USFWS. Consultation would be conducted at the site-specific level in tiered NEPA reviews. Table 4.2.3.6–1 summarizes the potential changes to biotic resources at INEL resulting from the proposed action. As noted in the table, no major differences in impact to biotic resources exist between the four tritium supply technologies and recycling facilities.

**Terrestrial Resources.**

*No Action.* Under No Action, the missions described in section 3.3.1 would continue at INEL. This would result in no changes to current terrestrial conditions at the site described in section 4.2.2.6.

*Tritium Supply and Recycling.* Construction and operation of the HWR, MHTGR, ALWR, or APT and recycling facilities would take place on the proposed TSS and would result in the disturbance of approximately 462, 562, 552, or 375 acres, respectively, of terrestrial resources, or less than 0.1 percent of INEL (table 4.2.3.6–1). These acreages include areas on which plant facilities would be constructed, as well as areas revegetated following construction. Vegetation within the proposed TSS would be destroyed during land clearing operations. Big sagebrush is the dominant plant within the proposed TSS (figure 4.2.2.6–1). Plant communities in which big sagebrush is the dominant overstory species are well represented on INEL, but are relatively uncommon regionally because of widespread conversion of shrub-steppe habitats to agriculture.

Constructing any of the tritium supply technologies and recycling facilities would have some adverse effects on animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would be destroyed during land-clearing activities. Construction activities would cause larger mammals and birds in the construction and adjacent areas to move to similar habitat nearby. The long-term survival of these animals would depend on whether the area to which they moved was at or below its carrying capacity. Because pronghorn use of the proposed TSS is relatively low (DOE 1992e), the tritium supply and recycling facility should not

**TABLE 4.2.3.6–1.—*Potential Impacts to Biotic Resources During Construction and Operation Resulting from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory***

| | | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| **Affected Resource Indicator** | **No Action** | **HWR** | **MHTGR** | **ALWR** | **APT** | **Tritium Recycling** |
| Acres of habitat disturbed | 0 | 462[a] | 562[a] | 552[a] | 375[a] | 202 |
| Wetlands potentially impacted | None | None | None | None | None | None |
| Aquatic resources potentially impacted | None | None | None | None | None | None |
| Number of threatened and endangered species potentially affected[b] | 0/0 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 |

[a] Acreage disturbed by each tritium supply technology may be obtained by subtracting the acreage for the tritium recycling facility from the tritium supply technologies and recycling acreage.

[b] The number of threatened and endangered species is represented by two data inputs (a/b) where: a - the number of Federal-listed threatened and endangered species, and b - the number of all other special status species (i.e., Federal candidate and/or state-listed species) that are potentially impacted.

Source: DOE 1993a.

have a lasting impact on this species. Nests and young animals living within the proposed TSS could be lost during construction. Areas disturbed by construction but not occupied by facility structures would be of minimal value to wildlife because they would be maintained as landscaped areas.

Activities associated with facility operations, such as noise and human presence, could affect wildlife living immediately adjacent to the tritium supply and recycling facility. These disturbances may cause some species to move from the area. A non-evaporative cooling design is proposed for all tritium supply technologies at INEL except for the APT. While there would be no impacts to vegetation from salt drift from an HWR, MHTGR, or ALWR, this may not be the case for the APT. A total of 10 separate cooling towers would be located along the length of the facility (section 3.4.2.4). Since design parameters for these towers are not known at this time, it is not possible to estimate impacts. This would be determined in future tiered NEPA documentation.

Construction and operation of a tritium supply facility alone would result in similar impacts to terrestrial resources but less than those described for a collocated tritium supply and recycling facility. Impacts would be less since 202 fewer acres of habitat would be disturbed.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have the same impacts described above for production at baseline tritium requirements.

Construction-related impacts of the less than baseline tritium requirement Phased APT would be similar to those described above. Some additional construction-related impacts could occur if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion activities would occur in the already developed main plant site.

*Potential Mitigation Measures.* The loss of habitat other than the facility footprint itself may be mitigated by revegetating with native species. This is particularly important since disturbed areas in shrub-steppe communities are generally recolonized by cheatgrass, a nonnative species, at the expense of native plants (DOE 1992e). Disturbance to wildlife living in areas adjacent to the new facilities may be reduced by preventing workers from entering undisturbed areas. It may be necessary to survey the TSS for the nests of migratory birds or eagles prior to construction and/or avoid clearing operations during the breeding season.

**Wetlands.**

*No Action.* Under No Action, the missions described in section 3.3.1 would continue at INEL with no changes to wetlands at INEL.

*Tritium Supply and Recycling.* Because there are no wetlands in the proposed TSS, construction and operation of any of the tritium supply technologies and recycling facilities would not impact this resource. Wetlands associated with the Big Lost River are located 1.5 miles from the site; therefore, impacts to these wetlands are not expected. Construction and operation of a tritium supply facility alone would not affect wetlands because there are no wetlands in the proposed TSS.

*Less than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have no wetland impact. Construction and operation of a Phased APT would also not affect wetlands because there are no wetlands in the proposed TSS.

*Potential Mitigation Measures.* Mitigation measures are not anticipated.

**Aquatic Resources.**

*No Action.* Under No Action, the missions described in section 3.3.1 would continue at INEL with no changes to aquatic resources at INEL.

*Tritium Supply and Recycling.* Construction and operation of any of the tritium supply technologies and recycling facilities would not impact aquatic resources since there are no surface water bodies in the proposed TSS. The nearest surface water body is the Big Lost River which is located 1.5 miles from the site. Temporary aquatic habitat may develop in evaporation and retention ponds, as well as in natural channels in the immediate vicinity of NPDES-permitted outfalls. Construction and operation of a tritium supply facility alone would not affect aquatic

resources because there are no surface water bodies in the proposed TSS.

*Less than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have no impact on aquatic resources at INEL. Construction and operation of a Phased APT would also not impact aquatic resources because there are no aquatic resources in the proposed TSS.

*Potential Mitigation Measures.* Mitigation measures are not anticipated.

**Threatened and Endangered Species.**

*No Action.* Under No Action, the missions described in section 3.3.1 would continue at INEL with no change to the current conditions of threatened and endangered species at INEL.

*Tritium Supply and Recycling.* Although the acreage of disturbed habitat would vary (table 4.2.3.6–1), no Federal-listed species would be affected by constructing any of the tritium supply technologies and recycling facilities at the proposed TSS, but several Federal candidate or state-listed species may be affected. Up to 462 acres of foraging habitat for the ferruginous hawk (Category 2) would be lost and the species would be discouraged from areas in close proximity to the construction site. However, the loss of foraging habitat is not expected to affect the viability of the population. Suitable nesting sites for this species are relatively rare on INEL and should be avoided (DOE 1992e). Construction activities could destroy the nests of the loggerhead shrike and disrupt foraging birds. Likewise, burrows and foraging habitat for the pygmy rabbit would be lost. The Townsend's western big-eared bat (Category 2) may roost in caves and forage throughout the proposed TSS (INEL 1992a:5). One state-listed sensitive plant species could potentially be affected by construction of the tritium supply and recycling facility. The plant species, tree-like oxytheca, has been collected at eight sites on INEL and at only two other sites in Idaho. If present, individual plants of this species could be destroyed during land clearing activities. Preactivity surveys would be required prior to construction to determine the occurrence of these species in the area to be disturbed.

During operation of the new facilities, the Townsend's western big-eared bat could forage at evaporation and stormwater retention ponds. No adverse impacts are expected due to facility operation.

Construction and operation of a tritium supply facility alone would result in similar impacts to threatened and endangered species but less than those described for a collocated tritium supply and recycling facility. Impacts would be less since fewer acres of habitat would be disturbed.

*Less than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would not be expected to result in adverse impacts to threatened, endangered, or sensitive species as described for the baseline tritium production requirement. Construction and operation of a Phased APT would have similar impacts on the Federal candidate and state-listed species discussed above for the baseline tritium production requirement.

*Potential Mitigation Measures.* Disturbance of threatened and endangered and special-status species would be avoided where possible. Land clearing activities could be planned to avoid nesting seasons or areas where oxytheca occur. A habitat restoration or propagation program would be developed for oxytheca if disturbance is unavoidable.

Consultation with the USFWS would be required if INEL is selected as the location for a tritium supply and recycling facilities and, if necessary, a detailed plan to mitigate impacts to Federal listed threatened and endangered species would be developed. Currently, no critical habitat has been designated for threatened and endangered species at INEL.

#### 4.2.3.7 *Cultural and Paleontological Resources*

Cultural and paleontological resources may be affected directly through ground disturbance during construction, visual intrusion of the project into the historic setting or environmental context of historic sites, visual and audio intrusions to Native American resources, and unauthorized artifact collecting and vandalism. Intensive cultural resources inventories and site evaluations have not been conducted for the majority of the proposed TSS. Site-specific surveys and evaluations would be conducted in conjunction with tiered NEPA documentation. Although the

location and acreage for proposed tritium facilities will vary, the effects on cultural and paleontological resources are based primarily on the amount of ground disturbance; therefore, the facilities with the greatest ground disturbance will have the greatest potential effect on cultural and paleontological resources. Some NRHP-eligible prehistoric and historic sites, important Native American resources and scientifically important paleontological resources may be affected by the proposed action.

**Prehistoric and Historic Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at INEL. Any impacts to prehistoric and historic resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Land disturbance for construction of the proposed tritium facilities (section 3.4) would range from 360 acres for the MHTGR to 173 acres for the APT (section 4.2.3.1). Acreages for the HWR and ALWR would be 260 and 350, respectively. Acreage required by the recycling facilities would be an additional 196 acres. Some NRHP-eligible prehistoric and historic sites are expected to occur within the acreages that would be disturbed during construction. The prehistoric sites could include residential bases, campsites, and limited activity locations. The historic sites could include homesteads, trash scatters, cattle camps, and ditches or canals. NRHP-eligible resources will be identified through project-specific inventories and evaluations, and any project-related effects would be addressed in tiered NEPA documentation. Operation of new facilities would not involve additional ground disturbance or increased activity; therefore, prehistoric and historic sites would not be affected.

*Less Than Baseline Operations.* No change in impacts to prehistoric and historic resources would be expected from operating the HWR at reduced capacity. Impacts for the MHTGR or ALWR would also not change from those described for the baseline requirement because the MHTGR or ALWR would not be a reduced size or operate at reduced capacity.

Construction and operation of the Phased APT would not change the expected impacts from the Full APT since the disturbed area would be the same in both scenarios.

*Potential Mitigation Measures.* If NRHP-eligible sites cannot be avoided through project design or siting, and would result in an adverse effect, then a Memorandum of Agreement may need to be negotiated between DOE, the Idaho State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation describing and implementing intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs. The appropriate level of data recovery for mitigation would be determined through consultation with the Idaho SHPO and the Advisory Council on Historic Preservation, in accordance with Section 106 of the *National Historic Preservation Act.* Mitigation measures for specific NRHP-eligible sites would be identified during tiered NEPA documentation.

**Native American Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at INEL. Any impacts to Native American resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Some Native American resources may occur within the acreages which would be disturbed during construction of the tritium facilities. Native American resources may include rock art and burials. Operation of facilities may create audio or visual intrusions on Native American sacred sites in the vicinity. Specific concerns about the presence, type, and locations of Native American resources would be identified through consultation with the potentially affected tribes, and any project-related effects would be addressed in tiered NEPA documentation.

*Less Than Baseline Operations.* Impacts to Native American resources would not change due to less than baseline tritium operation of the HWR, MHTGR or ALWR. Construction and operation of a Phased APT would have similar impacts on Native American resources as those described for the Full APT.

*Potential Mitigation Measures.* If Native American resources cannot be avoided through project design

and siting, then acceptable mitigation measures to lessen the effect on these resources would be determined in consultation with the potentially affected tribes. Such mitigations may include, but not be limited to, appropriate relocation of human remains according to the *Native American Graves Protection and Repatriation Act* and planting vegetation screens to reduce visual and audio intrusion. However, impacts to some Native American resources such as rock art sites may be mitigated as appropriate.

**Paleontological Resources.** Surface exposures of fossiliferous formations do not occur within areas designated for the proposed TSS. However, deep project-related excavation could encounter buried lava tubes or blisters which may have served as faunal traps. The only tritium supply technologies that would require excavations exceeding 50 feet would be the MHTGR and APT. In such a case, monitoring could be an appropriate mitigation. A certified paleontologist would be onsite during excavation to document any findings.

*Less Than Baseline Operations.* No change in impacts to paleontological resources would be expected due to reduced operation of the HWR, MHTGR or ALWR. Construction of a Phased APT may potentially have a slightly smaller impact on paleontological resources due to less excavation for APT tunnel length.

#### 4.2.3.8 *Socioeconomics*

Locating any of the tritium supply technologies alone or with recycling facilities at INEL would affect socioeconomics in the region. Section 3.2 provides descriptions for No Action, the tritium supply technologies, and tritium recycling. Siting tritium supply technology with or without a recycling facility at INEL would create changes in some of the communities in both the ROI and the economic study area. The in-migrating population could increase the demand for housing units. Additionally, there would be an associated increased burden on community infrastructure and subsequent effects on the public finances of local governments in the ROI. The increase of population could also burden transportation routes in the ROI.

Locating the ALWR at INEL would create the greatest changes during construction, but locating the HWR, MHTGR or ALWR would result in similar changes during operation. The APT would cause the fewest changes of the tritium supply technologies. None of these tritium supply technologies with a recycling facility would increase population, the need for additional housing, or local government spending in the ROI beyond 9 percent over No Action during peak construction or operation. Although the greatest percent increases in employment, population and housing, and public finance during construction and operation occur in the peak years of 2005 and 2010, respectively, the annual average increases over the construction period (2001 to 2005) are between less than 1 percent and 4 percent average growth annually, and 1 percent or less average annual growth during operation (2010 to 2050). From peak construction to full operation (2005 to 2010), annual average increases vary from decreases of 1 percent to increases of 1 percent. None of the annual average increases associated with tritium supply technologies and recycling facilities constitutes a major difference from the No Action annual average increases.

The effects of locating any of the tritium supply technologies alone or with recycling facilities at INEL are summarized in section 4.2.3. The following sections describe the effects that locating one of these technologies would have on the local region's economy and employment, population, housing, public finances, and local transportation.

**Employment and Local Economy.** Changes in employment and levels of economic activity in the 13-county economic study area from the proposed action at INEL are described in this section. Although specialized personnel, materials, and services required for construction and operation would be imported from outside the area, a significant portion of these requirements would be available in this economic study area. Figures 4.2.3.8–1 and 4.2.3.8–2 present the potential changes in employment and local economy that would occur with each of the technologies.

*No Action.* Under No Action, employment at INEL decreased to approximately 10,100 persons in 1994. This is a decrease of about 1,000 persons from the 1990 employment. INEL employment is projected to total almost 10,100 persons in 2010 and remain at this level through 2020. Historical and future employment projections at INEL are presented in appendix table D.2.1–1. The total INEL payroll was approximately $436 million in 1994 and is expected to remain at this level through 2010 (IN ISU 1994a).

Total employment in the economic study area is projected to grow less than 1 percent annually between 2001 and 2009 reaching 143,700 persons. Between 2010 and 2020, employment is expected to decrease annually by much less than 1 percent reaching 140,800 persons. The unemployment rate in the economic study area is expected to remain at 6.4 percent between 2001 and 2020. Per capita income is projected to increase from $17,800 to $20,900 during this 20-year period. No Action estimates are presented in appendix table D.3–2.

*Tritium Supply and Recycling.* Construction activities would begin between the years 2001 and 2003 and would be completed between the years 2007 and 2009. Phasing in of employment for the operation of the new facilities would begin in the year 2007, peak at full employment by the year 2010, and continue at this level into the future.

Locating any of the tritium supply technologies alone or with recycling facilities at INEL would create new jobs (direct) at the site. Indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new jobs. The total new jobs (direct and indirect) created would reduce unemployment and increase

income in the economic region surrounding INEL during both the construction and operation periods of the proposed action.

Construction. Siting a tritium supply technology and recycling facility at INEL would require a total of approximately 4,400 to 13,600 worker-years of activity over a 5- to 9-year construction period. This construction-related employment would indirectly create other jobs in the economic study area and total employment would grow at an annual average rate of 2 to 3 percent until the peak year of 2005. Between peak construction (2005) and full operation (2010) average annual growth in employment would vary from a decrease of less than 1 percent under the ALWR to an increase of much less than 1 percent for the HWR, MHTGR, and APT. Figure 4.2.3.8–1 gives the estimates of total jobs (direct and indirect) that would be created during peak construction (year 2005) for each of the tritium supply technologies with recycling and the recycling facility's contribution to employment growth.

As employment opportunities grow in the economic study area due to the proposed action, the unemployment rate would be reduced from the No Action estimate of 6.4 percent. Figure 4.2.3.8–2 presents a comparison of unemployment rates for the different tritium supply technologies with recycling during peak construction in the year 2005. During the project's peak construction phase, the unemployment rate would be 4.5 percent, for any of the tritium supply technologies collocated with recycling. The contribution to the unemployment rate resulting from the tritium recycling facility is also indicated.

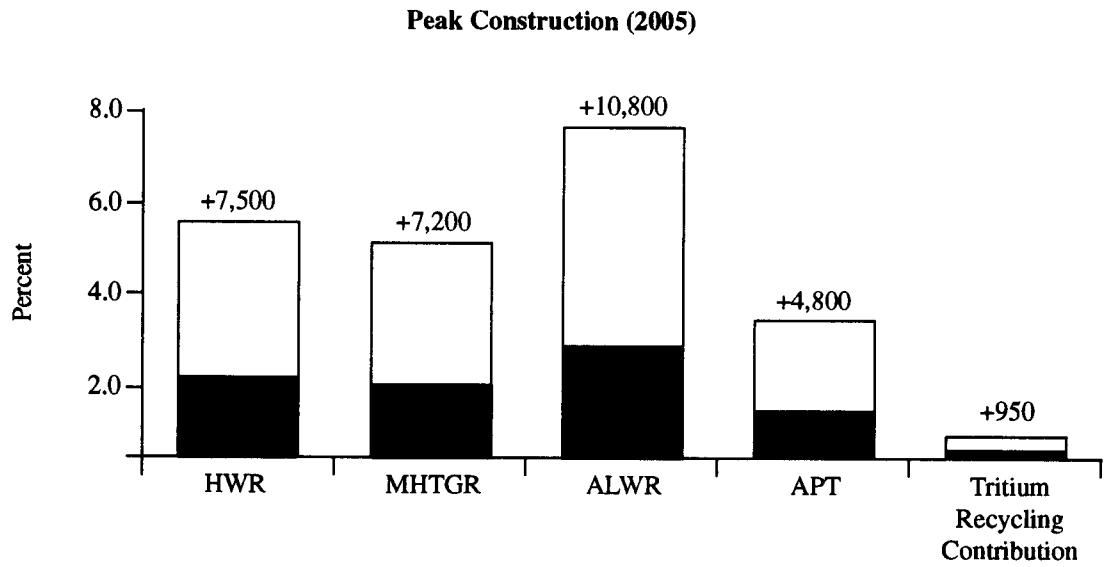
Income in the economic study area would also increase, particularly during peak construction as shown in figure 4.2.3.8–2. Per capita income is expected to increase at an annual average of 1 to 2 percent until the peak year of construction, 2005. Between 2005 and 2010 annual average growth in per capita income is expected to increase by 1 percent for all of the tritium supply technologies with recycling. In comparison, under No Action, per capita income is expected to increase 1 percent annually.

Operation. Siting of tritium supply and recycling facilities would help offset the employment and income losses at INEL from the approximate 1,000 jobs lost between 1990 and 1994. Employment for operation would begin phasing in as construction neared completion and construction-related employment began phasing out. It is expected that full operation employment would peak in the year 2010 and continue at this level into the future. Figure 4.2.3.8–1 presents the total project-related jobs projections (direct and indirect) for each of the tritium supply technologies and recycling facilities for the year 2010. However, the addition of these new project-related jobs would not dramatically affect future employment growth in the economic study area. Overall employment growth is expected to be flat from 2010 through 2020.

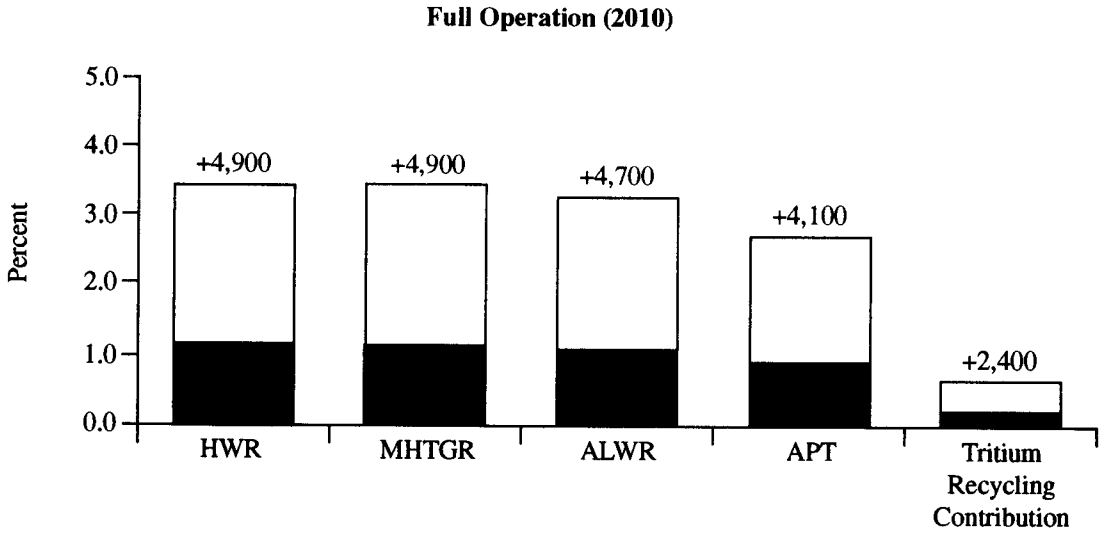
Creation of additional job opportunities would reduce the unemployment rate to below that projected for No Action. Figure 4.2.3.8–2 presents the differences in unemployment rates during the first year of full operation employment (2010) for each of the tritium supply technologies and recycling facilities. From the years 2010 to 2020, unemployment would be reduced from the No Action projection of 6.4 percent to a range of 4.6 to 4.9 percent for all of the technologies.

Income would also increase slightly in the economic study area as a result of the proposed action. Per capita income differences for tritium supply technologies and recycling facilities for the year 2010 are given in figure 4.2.3.8–2. Per capita income annual average increases would be about 1 percent between the years 2010 and 2020 for all of the tritium supply technologies and recycling facilities considered for location at INEL. The No Action projected annual average increase during the same period would also be approximately 1 percent.

*Tritium Supply Alone.* Construction of the tritium supply technologies without recycling facilities would begin between 2001 and 2003 and would be completed between 2007 and 2009. Employment for the operation of the facility would begin in the year 2007 and reach full employment by 2010. Locating any of the tritium supply technologies at INEL would create new jobs at the site and indirectly create other jobs in the region. However, this job creation and the additional economic effects would be less than the effects that would occur with the collocation of the tritium supply technologies with the recycling facilities.




Note: Under No Action, total employment is 141,500 jobs.

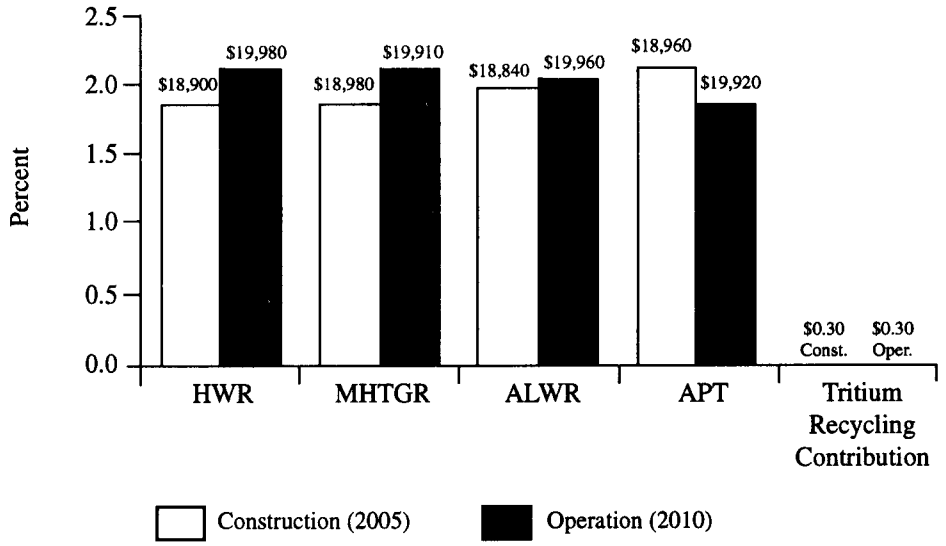



☐ Indirect project-related jobs ■ Direct project-related jobs

Note: Tritium supply alternatives include recycling. To calculate tritium supply only, subtract tritium recycling contribution. Under No Action, total employment is 144,300 jobs. The percent increase in total employment during peak construction and operations was calculated by dividing the total project-related jobs by the total employment under No Action.

Source: Appendix table D.3–4.

**FIGURE 4.2.3.8–1.—*Total Project-Related Employment (Direct and Indirect) and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Economic Study Area.***




Note: Under No Action, per capita income is projected to be $18,570 in 2005 and $19,570 in 2010.

Note: Tritium supply alternatives include recycling. To calculate tritium supply only, subtract tritium recycling contribution.

Source: Appendix table D.3–4.

**FIGURE 4.2.3.8–2.—*Unemployment Rate, Per Capita Income, and Percentage Increase from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Economic Study Area.***

Construction. Construction of a tritium supply technology alone would require a total of approximately 3,400 to 12,700 worker-years of activity over a 5- to 9-year period. New jobs would be created, but this employment growth would be much less than 1 percent over No Action estimates. Appendix table D.3–3 presents the estimates of employment that would be created during peak construction in 2005, or these new jobs can be calculated by subtracting tritium recycling contribution from tritium supply technologies and recycling in figure 4.2.3.8–1.

Although the construction of the tritium supply technology alone would create new jobs, the effects of constructing this facility would not be enough to greatly affect the unemployment rate projected for No Action. Additionally, per capita income in the region would rise only slightly above that estimated for No Action. Estimates of unemployment rate and per capita income are presented in appendix table D.3–3, or can be derived for tritium supply alternatives by subtracting tritium recycling contribution in figure 4.2.3.8–2.

Operation. Operation employment for the tritium supply technologies alone would begin phasing in at the end of the construction period and be at full employment in the year 2010. Full employment is expected to be maintained for the life of the facility. Estimates for full employment in 2010 are presented in appendix table D.3–3. Total project related jobs created by the tritium supply technologies alone can be calculated by subtracting the tritium recycling contribution in figure 4.2.3.8–1.

The addition of new jobs during operation would reduce the unemployment rate below the projection for No Action. The unemployment rate for 2010, the first year of full operation employment, is presented in appendix table D.3–3, or can be derived by subtracting tritium recycling contribution in figure 4.2.3.8–2. Unemployment would be reduced from the No Action projection of 6.4 percent to a range of 5.4 to 5.6 percent during the years 2010 to 2020 depending upon the technology selected.

The creation of new jobs as a result of tritium supply operation would also increase income slightly over the No Action estimates. Appendix table D.3–3 presents the per capita income for the facility for the year 2010. During the years 2010 to 2020, per capita income annual increases would be 1 percent, the same annual increase projected under No Action.

*Less Than Baseline Operations.* Tritium supply technologies that provide less than the baseline tritium requirement are described in section 3.1. These options may or may not be collocated with the tritium recycling facilities. The options include lowering the power in the HWR, using fewer target rods in the MHTGR and ALWR, and the phased approach for the APT.

Construction. The less than baseline operations case for the HWR, ALWR, and MHTGR would have the same construction workforce requirements as discussed in the tritium supply and recycling and tritium supply only sections. Therefore, employment and economic effects in the region would be the same.

The Phased APT would require the same total number of construction workers as the Full APT, but the construction period would span the years 1999 to 2008 instead of 2003 to 2007. Additionally, peak construction would occur in 2003 instead of 2005. The effects on the economic study area's employment, unemployment rate, and per capita income as a result of constructing the Phased APT are presented in appendix table D.3–3. Appendix table D.3–4 presents the effects on employment, unemployment rate, and per capita income for constructing the Phased APT with tritium recycling facilities. Generally, average annual increases in employment and income are similar to those for the Full APT, but these increases are over a longer period of time. These increases are between less than 1 percent and 2 percent, the same as the No Action estimates.

Operation. Operation workforce requirements for the less than baseline tritium case for the HWR, MHTGR, ALWR, and the Phased APT would be the same as those described in the tritium supply and recycling and tritium supply only sections. Thus, regional employment and economic effects would be the same.

**Population and Housing.** Changes to ROI population and housing expected from the proposed action at INEL are described in this section. Additional population could be expected to in-migrate to the INEL region and these people would be expected to

reside in cities and counties within the ROI in the same relative proportion as the existing population. Increases to population could lead to a demand for additional housing units beyond existing vacant housing available during construction or operation phases of the proposed action. Figures 4.2.3.8–3 and 4.2.3.8–4 present changes in population and housing for all of the tritium supply technologies and recycling facilities.

*No Action.* Population and housing annual average increases between 2001 and 2005 are projected to be less than 1 percent. Annual average increases are also projected to be less than 1 percent between 2005 and 2010. Population in the ROI is estimated to reach 207,300 in 2010 and 215,200 in 2020. Total housing units in the ROI are estimated to reach 75,400 in 2010 and 78,300 in 2020. No Action estimates are given in appendix tables D.3–5 and D.3–8.

*Tritium Supply and Recycling.* It is expected that the greatest increase caused by the proposed action would increase population and housing demands in the ROI by 9 percent over No Action projections during peak construction. The effects are expected to be fewer (2 percent) during the operation phase of the proposed action.

Construction. Construction activities would be phased over a 5- to 9-year period. Figure 4.2.3.8–3 illustrates that during peak construction (year 2005), the ALWR would create the largest population and housing demand increases over No Action, and the APT would have the fewest effects. The increase in population could require some additional housing units beyond what is currently available in the existing housing mix. However, any requirements for additional housing units in the ROI would be at annual average increases of 3 percent in the first 3 years of construction of the ALWR, followed by an approximately 1 percent annual decrease until peak operation. The other tritium supply technologies would have annual average population and housing demand growth of 2 percent or less. Therefore, there would not be any major effects on any of the ROI communities.

Operation. Operation of any of the tritium supply technologies and recycling facilities is expected to reach full employment by 2010. In-migrating population is expected to demand housing units similar to the existing housing mix in the ROI. Figure 4.2.3.8–4 shows that population increases and potential demand for additional housing units over No Action projections is less than 2 percent for the ROI in this peak year. Given that the operations of the proposed action would be phased in over a 4-year period, it is expected that existing vacancies would absorb much of this new demand and that No Action requirements would be exceeded by very few units.

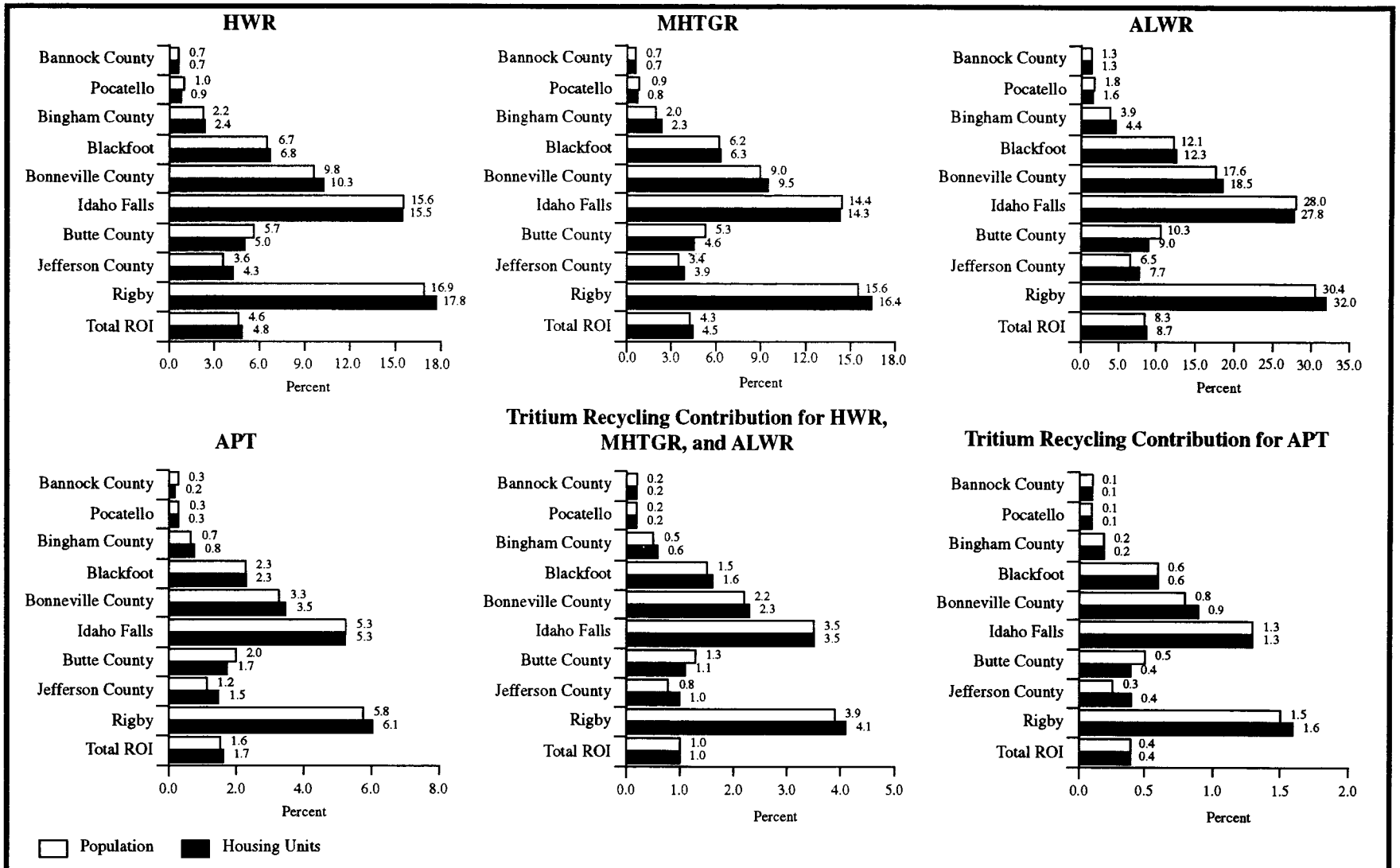
*Tritium Supply Alone.* Locating a tritium supply only at INEL would not increase population or housing demands in the ROI more than 8 percent over No Action projections during the construction period or 1 percent during operation.

Construction. Construction activities for the tritium supply technologies alone would be lower than if collocated with the tritium recycling facilities. The greatest increase in population and housing demand would occur during peak construction in 2005. Appendix tables D.3–6 and D.3–9 show that available vacancies in the existing housing mix would probably accommodate the expected population growth.

Operation. Full employment levels for any of the tritium supply only technologies would be reached by the year 2010. In-migrating population would be expected to require housing units similar to the existing mix in the ROI. These requirements would be lower than those of the tritium supply technologies collocated with the recycling facilities. Potential demand for housing units would be less than 1 percent in the first year of full employment as illustrated in appendix table D.3–9. It is expected that existing vacancies would absorb most of this new demand as employment would be phased in during the years 2007 through 2010.

*Less Than Baseline Operations.* Population increases and housing demands would be the same or lower during construction and operation of tritium supply technologies operated at less than baseline tritium requirements than the alternatives discussed in the tritium supply and recycling and tritium supply only sections.

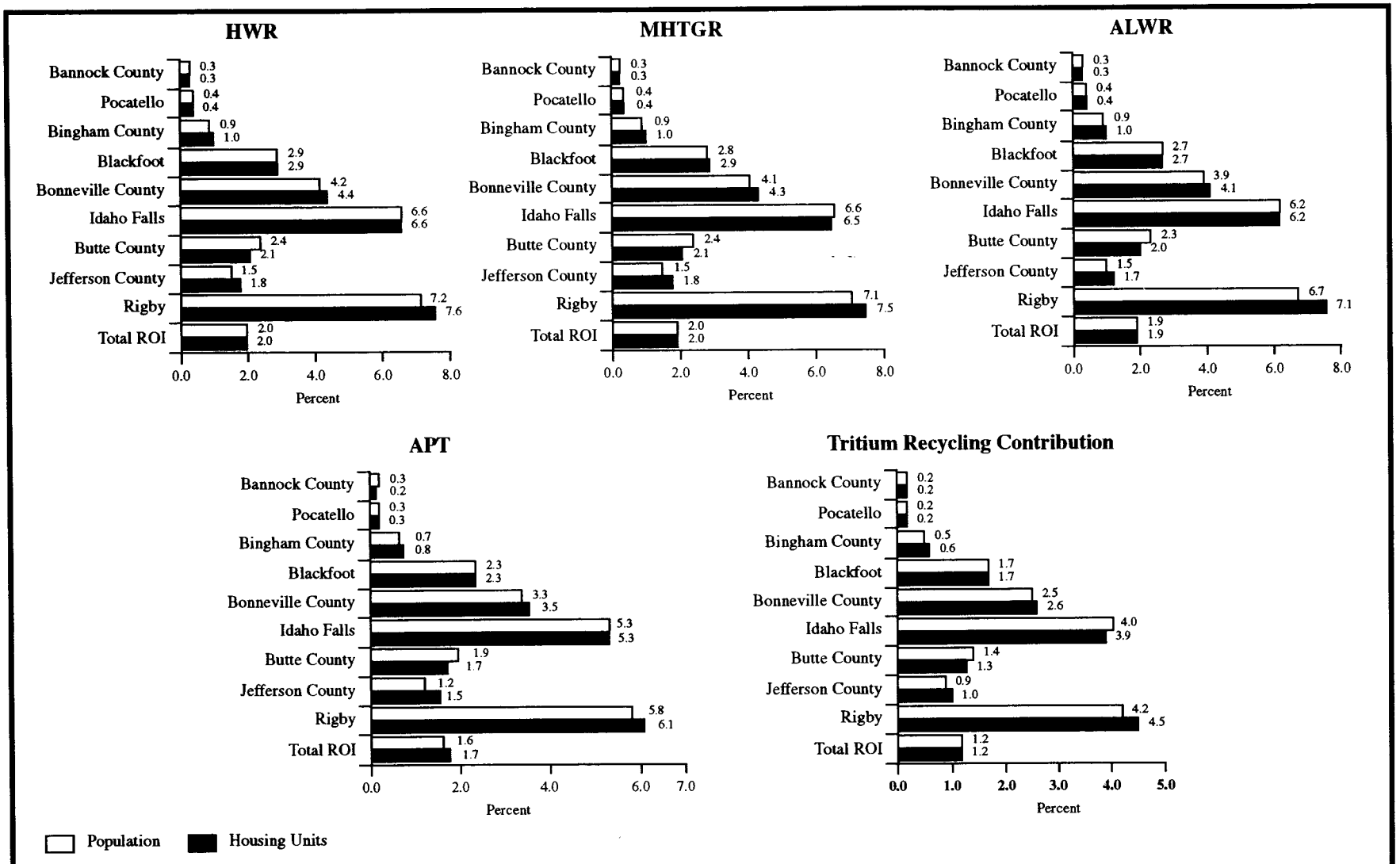
Construction. Population increases and housing demands would be the same as those given in figure 4.2.3.8–3 for the HWR, MHTGR and ALWR. The




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–6, D.3–7, D.3–9 and D.3–10.

Source: Appendix tables D.3–7 and D.3–10.

**FIGURE 4.2.3.8–3.—** ***Population and Housing Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–6, D.3–7, D.3–9 and D.3–10.

Source: Appendix tables D.3–7 and D.3–10.

**FIGURE 4.2.3.8–4.—*Population and Housing Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2010.***

Phased APT would increase population and housing demand during construction to the same level as the Full APT, but this would occur over a longer construction period with lower average annual increases. Also, the peak construction year would be 2003 instead of 2005. The effects of the Phased APT on population and housing are presented in appendix tables D.3–6 and D.3–9, respectively. Appendix tables D.3–7 and D.3–10 present the results of constructing the Phased APT with the tritium recycling facilities.

Operation. The effects on population and housing of operating the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirements would be the same as those given in figure 4.2.3.8–4.

**Public Finance.** Fiscal changes could occur in some ROI local jurisdictions from the proposed action. Factors influencing these changes include residence of project-related employees and their dependents, cost and duration of construction, and economic conditions in the ROI once the new facilities are operational.

Adding the proposed action to INEL would increase population, resulting in more revenues for ROI local jurisdictions. Additional population would also increase public service expenditures. Figures 4.2.3.8–5 through 4.2.3.8–8 present the potential fiscal changes that would occur with the different tritium supply technologies and recycling facilities.

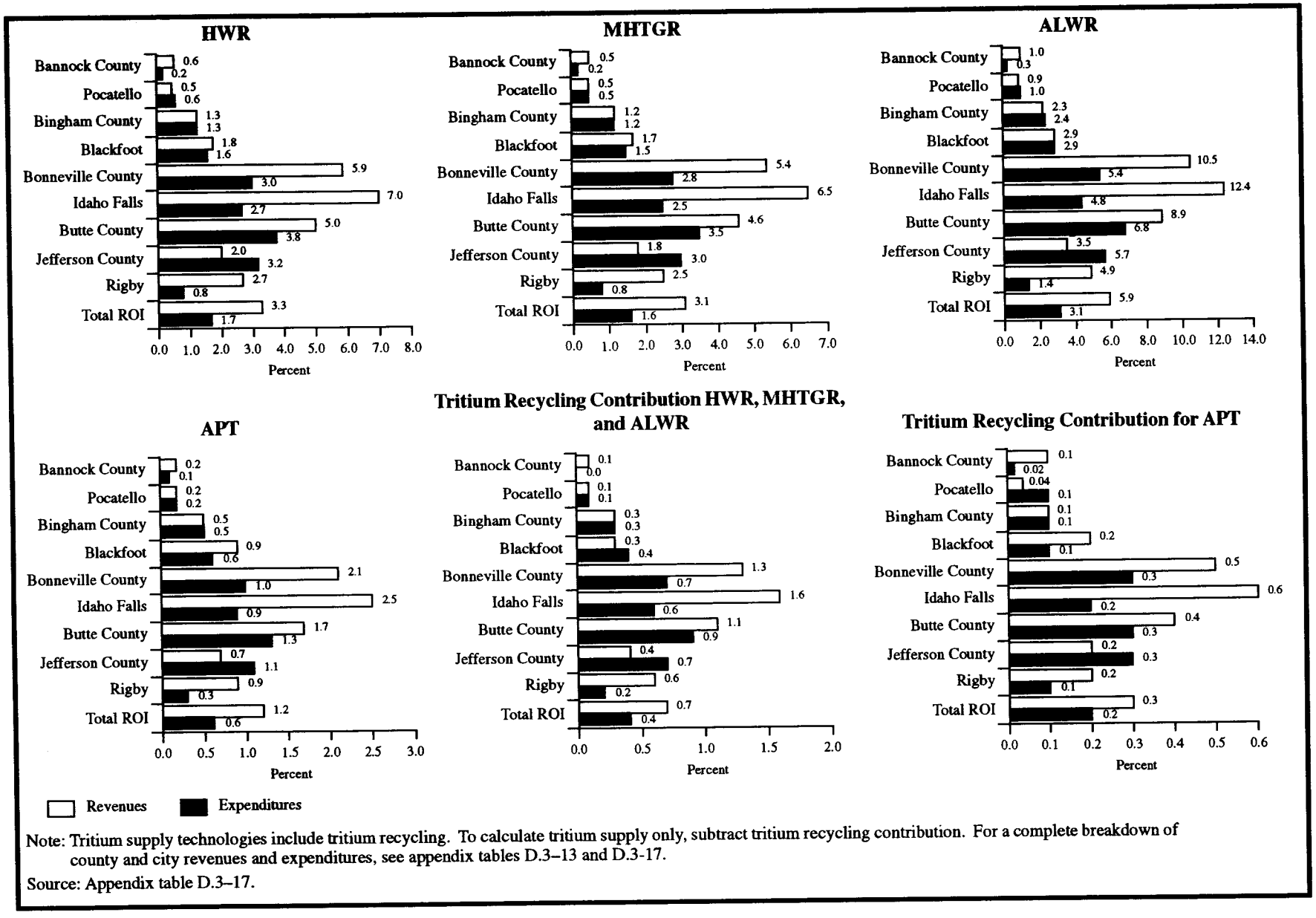
*No Action.* No Action is the reference condition against which tritium supply technologies and recycling facilities are compared. Appendix tables D.3–11 and D.3–12 present the 1992 public finance characteristics for local ROI jurisdictions. Appendix tables D.3–13 through D.3–20 present the impacts from tritium supply technologies alone or collocated with recycling facilities compared to No Action during construction and operation for the local counties, cities, and school districts. Between 2001 and 2005, ROI counties, cities, and school districts are projected to increase total revenues on an annual average of less than 1 percent. Total expenditures are also projected to increase on an annual average of less than 1 percent for ROI counties, cities, and school districts between 2001 and 2005. Between the peak year of construction (2005) and full operation (2010), total revenues and expenditures are also expected to increase by less than 1 percent.

Between 2010 and 2020, projected annual average increases in total revenues are less than 1 percent for counties, cities, and school districts in the ROI. Total expenditures are also projected to increase on an average by less than 1 percent for ROI jurisdictions between 2010 and 2020.

*Tritium Supply and Recycling.* The proposed action at INEL would create some fiscal benefits to local jurisdictions within the ROI. Some local government finances would be affected during the construction and operation phases of the proposed action. Construction-related effects on revenues and expenditures could span a period of 5 to 9 years with the peak occurring in 2005. The effects of the operation phase would peak in 2010 and remain at this level throughout the life of the proposed action.

Construction. The public finances of counties, cities, and school districts within the ROI would be affected by the construction-related activities associated with the proposed action. Initially, there would be slight increases to some local government jurisdictions' revenues and expenditures which would peak in the year 2005 and then decline as construction neared completion. Figures 4.2.3.8–5 and 4.2.3.8–7 give the revenue and expenditure changes of ROI local government jurisdictions over No Action during peak construction for the four tritium supply technologies and recycling facilities. Under the ALWR, revenues and expenditures would increase annually between 4 percent to less than 1 percent in the first 3 years of construction. After the peak construction year, there would be decreases of less than 1 to 2 percent annually until 2010. Under the HWR and MHTGR, revenues and expenditures would increase annually between 2 and less than 1 percent between 2002 and 2005 and then growth would be flat until 2010. Under the APT and the No Action estimates, local government revenues and expenditures would increase on an annual average of less than 1 percent.

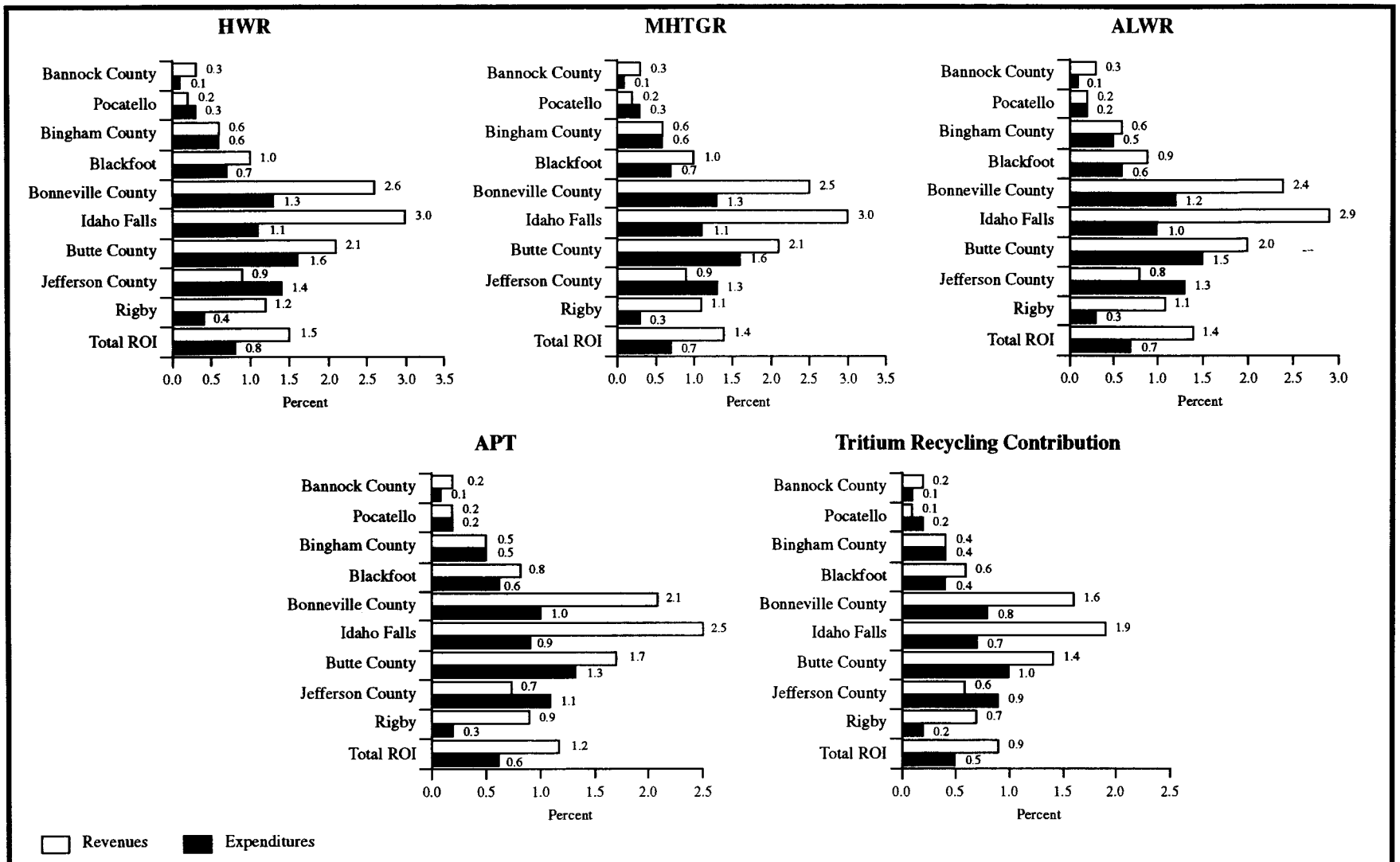
Operation. The effects on the ROI local government finances of phasing in operation together with phasing out construction would be fewer than the effects at peak or full operation (year 2010). The effects that the four tritium supply technologies and recycling facilities would have on county, city, and




Note: Tritium supply technologies include tritium recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of county and city revenues and expenditures, see appendix tables D.3–13 and D.3-17.

Source: Appendix table D.3–17.

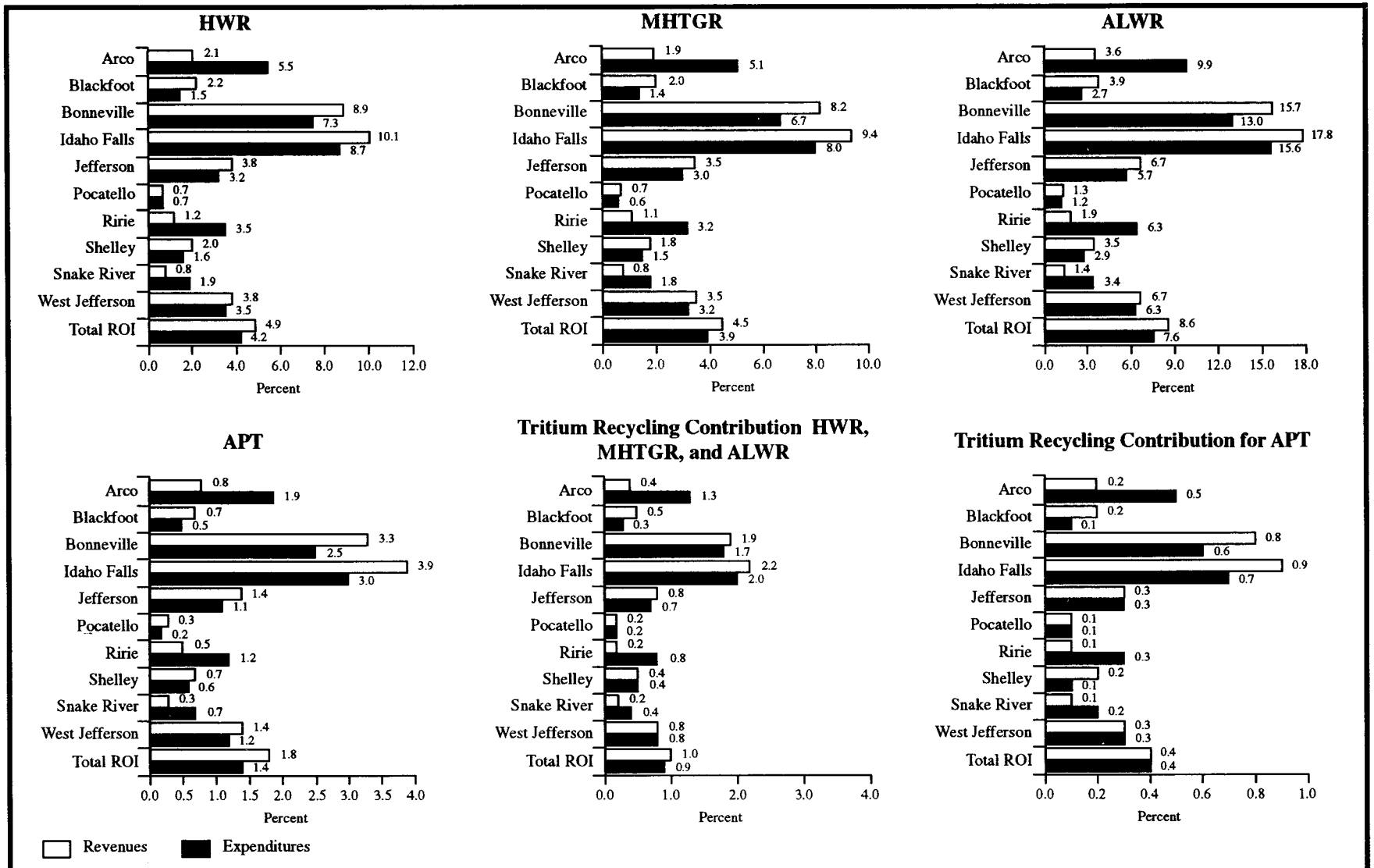
**FIGURE 4.2.3.8–5.—*City and County Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2005.***




Note: Tritium supply technologies include tritium recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of county and city revenues and expenditures, see appendix tables D.3–14 and D.3-18.

Source: Appendix table D.3–18.

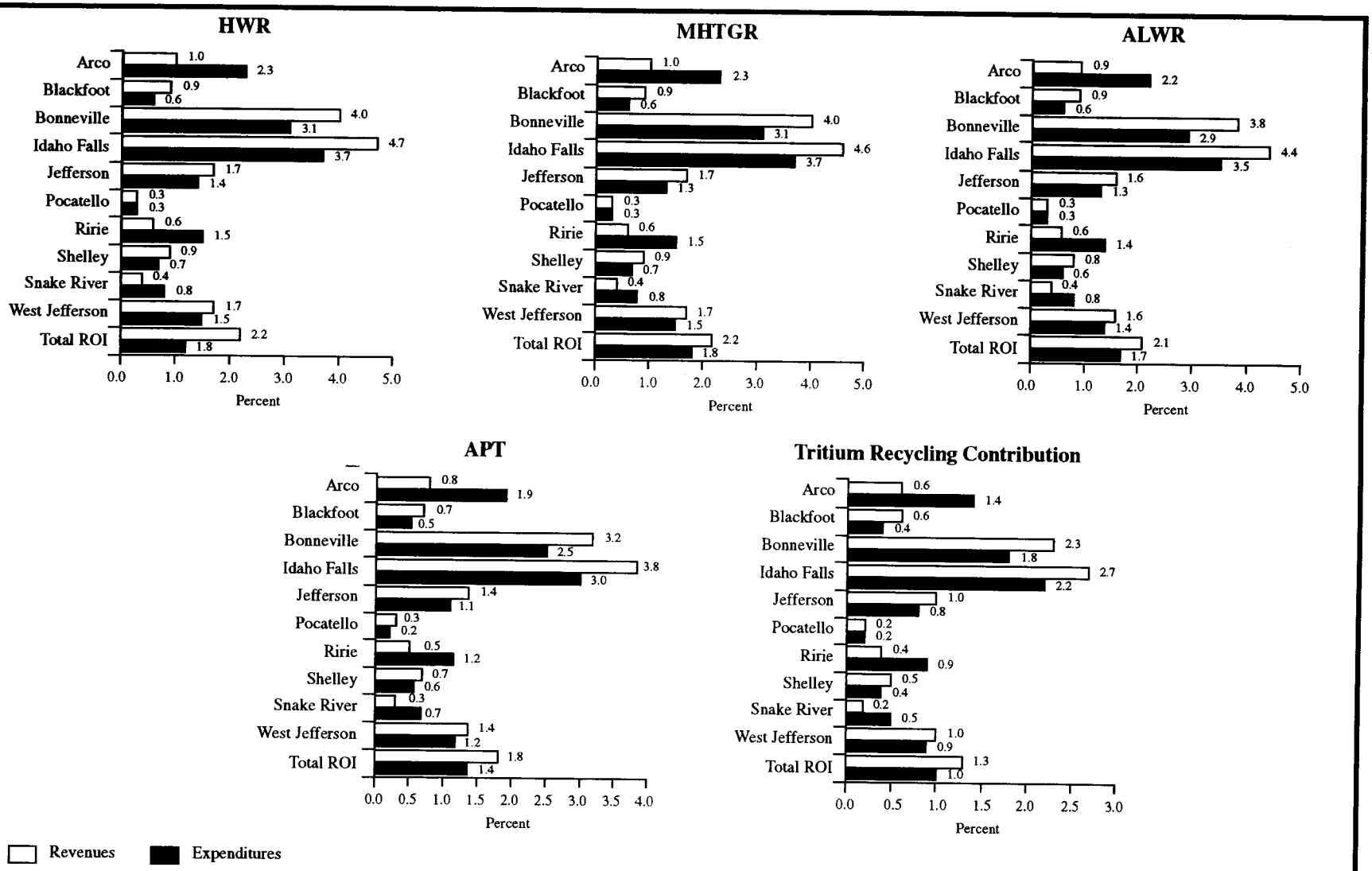
**FIGURE 4.2.3.8–6.—*County and City Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2010.***




Note: Tritium supply technologies include tritium recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of school district revenues and expenditures, see appendix tables D.3–15 and D.3-19.

Source: Appendix table D.3–19.

**FIGURE 4.2.3.8–7.—*School District Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2005.***




Note: Tritium supply technologies include tritium recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of school district revenues and expenditures, see appendix tables D.3–16 and D.3-20.

Source: Appendix table D.3–20.

**FIGURE 4.2.3.8–8.—*School District Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2010.***

school district revenues and expenditures are presented in figures 4.2.3.8–6 and 4.2.3.8–8. Between 2010 and 2020, revenues are expected to increase slightly but at an average annual rate of less than 1 percent for all jurisdictions. Expenditures would also increase slightly to the year 2020 at an annual average of less than 1 percent. No Action local government revenues and expenditures would also increase at an average annual rate of less than 1 percent.

*Tritium Supply Alone.* Locating the tritium supply without the recycling facilities at INEL would create some fiscal benefits to local jurisdictions within the ROI, but these effects would be less than the effect of collocation with tritium recycling.

Construction. Between the first year of construction and the year 2005, revenues and expenditures would increase annually between less than 1 percent and 3 percent. Between 2005 and 2010, revenues and expenditures would decrease annually between less than 1 percent and 2 percent. Appendix tables D.3–13 and D.3–15 present the revenue and expenditure changes of ROI local governments over No Action during peak construction of the tritium supply technologies alone.

Operation. The operation phase of the tritium supply only would affect the public finances of counties, cities, and school districts in the ROI, but these effects would be less than those resulting from operating the tritium supply technologies with the recycling facilities. Appendix tables D.3–14 and D.3–16 present the effects that operation would have on these local jurisdictions in the year 2010. During the years 2010 to 2020, revenues and expenditures are expected to increase annually by less than 1 percent. In comparison, No Action local government revenues and expenditures would increase at an average annual rate of 1 percent.

*Less Than Baseline Operations.* The fiscal benefits that local jurisdictions would accrue from the location of a tritium supply technology alone or collocated with recycling would be the same or less if the tritium supply technologies were operated at less than baseline tritium requirements.

Construction. Increases in local jurisdictions' revenues and expenditures would be the same as those given in figures 4.2.3.8–5 and 4.2.3.8–7 if the HWR, MHTGR or ALWR are built. If the Phased APT is constructed, the effects would peak in the year 2003 instead of 2005, and the annual average increases would be lower. Appendix tables D.3–13 through D.3–16 present the revenue and expenditure changes as a result of constructing the Phased APT for all ROI jurisdictions. Revenue and expenditure changes resulting from the construction of the Phased APT with tritium recycling are presented in appendix tables D.3–17 through D.3–20.

Operation. Operation of the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirements would have the same effects on local jurisdictions' finances as those presented in figures 4.2.3.8–6 and 4.2.3.8–8.

**Potential Mitigation Measures.** Adding new missions to INEL would create new jobs and generally benefit the local economy through increased earnings in the ROI. Some mitigation measures may be required, such as Federal aid to local school districts where additional school age children would attend as a result of the proposed action. These new missions at INEL would increase population and the demand for additional housing units. Temporary housing units and mobile homes would help to alleviate the demand for new housing during the construction phase of the proposed action. Generally, construction would be phased over a period of 5 to 9 years with peak construction occurring in the year 2005. Phasing the start of operation employment and training between 2005 and 2010 would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

**Local Transportation.** The following is a description of the effects on local transportation resulting from locating new missions at INEL. Construction and operation of tritium supply technologies and recycling facilities are expected to increase traffic volume and flow on site access routes.

*No Action.* Under No Action, the worker population at INEL would not increase. Therefore, any increases in traffic would not be the result of DOE-related activities at INEL. Segments providing access to INEL include U.S. Route 20/26, State

Route 33, and State Route 22/23. Traffic conditions on site access roads would remain as described in section 4.2.2.8.

*Tritium Supply and Recycling.* The proposed action at INEL would result in increases, depending on the tritium supply technology, of worker population at the site. Traffic volume on site access roads leading to and from INEL would increase due to the additional workforce. The primary access route to INEL is U.S. Route 20/26. This route would carry the greatest increase in traffic from site development. Currently this route and secondary branches leading to the various internal areas of INEL are congested during peak travel time. Locating the MHTGR or ALWR at INEL would have the greatest effect on traffic volume and flow.

*Tritium Supply Alone.* Locating a tritium supply technology without the recycling facility at INEL would result in increased worker population, thereby increasing traffic on site access roads. However, the effects on traffic would be less than siting the tritium recycling facility with any one of the supply technologies.

*Less Than Baseline Operations.* The effects on traffic flow rates would be the same whether or not the HWR, MHTGR or ALWR were operated at baseline or less than baseline tritium requirements. Construction of the Phased APT instead of the Full APT would have reduced traffic volume and flow rates during the construction phase.

*Potential Mitigation Measures.* Mitigation of traffic conditions may be necessary due to the proposed action at INEL. Potential mitigation of impacts to the local transportation network could include widening and extension of U.S. Route 20/26, the primary access route to INEL, as well as possible realignment of roadways and construction of interchanges at roadway intersections overburdened by increased vehicle traffic and congestion. In addition, internal access routes connecting U.S. Route 20/26 with the project area could be upgraded to carry the increased load.

#### 4.2.3.9 *Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents*

This section describes the impacts of radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or accidents at facilities involved with the tritium supply technologies and recycling facilities at INEL. The section first describes the impacts from normal operation followed by a description of impacts from facility accidents.

During normal operation at INEL, all tritium supply technologies and recycling facilities would result in impacts that are within regulatory limits. The risk of adverse health effects to the public and to workers would be small.

For facility accident impacts, the results indicate that for all technologies, the risk of fatal cancers (taking into account both the probability of the accident and its consequences) from an accidental release of radioactive or hazardous chemical substances at INEL is low when compared to fatal cancers from all causes, even for a severe accident.

The impact methodology is described in section 4.1.9. Summaries of the radiological and chemical impacts associated with normal operation are presented in tables 4.2.3.9–1 and 4.2.3.9–2, respectively. Summaries of impacts associated with postulated accidents are given in tables 4.2.3.9–3 and 4.2.3.9–4. Detailed results are presented in appendix E for normal operation and in appendix F for accidents.

**Normal Operation.**

*No Action.*

The current missions at INEL are described in section 3.3.1. Site representatives have identified those facilities that will continue to operate and others, if any, that will become operational by 2010. Based on that information, the radiological and chemical releases for 2010 and beyond were developed and used in the impacts assessments.

Radiological Impacts. As shown in table 4.2.3.9–1, No Action would result in a calculated annual dose of

**TABLE 4.2.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory***

| | | Tritium Supply Technologies and Recycling | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No Action | HWR[a] | MHTGR[a] | ALWR[a] | | APT | | | Tritium Recycling |
| | | | | Large | Small | Full[a] | | Phased | |
| Affected Environment | | | | | | Helium-3 Target System | SILC Target System | Helium-3 Target System | |
| **Maximally Exposed Individual (Public)[b]** | | | | | | | | | |
| Dose (mrem/yr)[c] | $6.0 \times 10^{-3}$ | 0.29 | 0.19 | 0.36 | 0.36 | 0.11 | 0.16 | 0.11 | 0.11 |
| Percent of natural background[d] | $1.7 \times 10^{-3}$ | 0.084 | 0.053 | 0.10 | 0.10 | 0.032 | 0.047 | 0.032 | 0.031 |
| 40-year fatal cancer risk | $1.2 \times 10^{-7}$ | $5.9 \times 10^{-6}$ | $3.8 \times 10^{-6}$ | $7.3 \times 10^{-6}$ | $7.3 \times 10^{-6}$ | $2.3 \times 10^{-6}$ | $3.3 \times 10^{-6}$ | $2.3 \times 10^{-6}$ | $2.2 \times 10^{-6}$ |
| **Population Within 50 Miles** *Year 2030* | | | | | | | | | |
| Dose (person-rem) | 0.037 | 53 | 37 | 73 | 71 | 23 | 32 | 23 | 22 |
| Percent of natural background[d] | $7.0 \times 10^{-5}$ | 0.1 | 0.069 | 0.14 | 0.13 | 0.042 | 0.060 | 0.042 | 0.041 |
| 40-year fatal cancers | $7.4 \times 10^{-4}$ | 1.1 | 0.73 | 1.5 | 1.4 | 0.45 | 0.64 | 0.45 | 0.44 |
| **Worker Onsite** | | | | | | | | | |
| Average worker dose (mrem/yr)[c] | 30 | 33 | 31 | 49 | 41 | 34 | 34 | 34 | 4 |
| 40-year fatal cancer risk | $4.8 \times 10^{-4}$ | $5.2 \times 10^{-4}$ | $5.0 \times 10^{-4}$ | $7.9 \times 10^{-4}$ | $6.6 \times 10^{-4}$ | $5.4 \times 10^{-4}$ | $5.5 \times 10^{-4}$ | $5.4 \times 10^{-4}$ | $6.4 \times 10^{-5}$ |
| Total workforce dose (person-rem/yr) | 220 | 261 | 250 | 392 | 322 | 273 | 274 | 273 | 1.6 |
| 40-year fatal cancers | 3.5 | 4.2 | 4.0 | 6.3 | 5.2 | 4.4 | 4.4 | 4.4 | 0.026 |

[a] Includes impacts from No Action facilities.

[b] The location of the maximally exposed individual varies depending on the tritium supply technology.

[c] The applicable radiological limits for an individual member of the public are 10 mrem per year resulting from site operations for the air pathways, 4 mrem from the drinking water pathway, and 100 mrem per year from all pathways combined (DOE Order 5400.5). The radiological limit for an individual worker is 5,000 mrem per year (40 CFR 835).

[d] Natural background levels: to the average individual is 353 mrem per year; to the population in the year 2030 is 53,270 person-rem.

Note: SILC - spallation-induced lithium conversion.

Note: Model results. See appendix sections E.2.2, E.2.4, and E.2.4.2.

$6.0 \times 10^{-3}$ mrem to the maximally exposed member of the public, which projects to an estimated fatal cancer risk of $1.2 \times 10^{-7}$ from 40 years of total site operation. This annual dose is within radiological limits and is $1.7 \times 10^{-3}$ percent of the natural background radiation dose received by the average person living near INEL.

The population dose from total site operation in the year 2030 was calculated to be 0.037 person-rem, which projects to an estimated $7.4 \times 10^{-4}$ fatal cancers over 40 years of total site operation. This population dose would be approximately $7.0 \times 10^{-5}$ percent of the annual dose received by the surrounding population from natural background radiation.

The annual average dose to a site worker from No Action would be 30 mrem, which projects to an estimated fatal cancer risk of $4.8 \times 10^{-4}$ from 40 years of site operation. The annual dose to the total site workforce would be 220 person-rem, which projects to an estimated 3.5 fatal cancers from 40 years of total site operation. These estimated worker doses are based on the measured doses at INEL from 1989 to 1992 and the projected employment for the year 2010.

Hazardous Chemical Impacts. No Action at INEL would result in a calculated HI of $1.7 \times 10^{-4}$ and no cancer risk to the maximally exposed member of the public. The worker HI and cancer risk were calculated to be 0.021 and 0, respectively. These values are within the acceptable regulatory health limits.

*Tritium Supply and Recycling.*

There would be no radiological releases during the construction of new tritium recycling facilities or new facilities that are associated with tritium supply technologies under consideration. Limited hazardous chemical releases are anticipated as a result of construction activities. However, concentrations would be within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The impacts from radiological and hazardous chemicals from each tritium supply technology considered are the summations of the impacts from the various facilities in operation for that technology. The resulting doses and potential health effects to the public and workers from each tritium supply technology are described below.

Radiological Impacts. Radiological impacts to the public resulting from normal operation from various tritium supply technologies and recycling facilities at INEL are listed in table 4.2.3.9–1. The supporting analysis is provided in appendix section E.2.4.2.

The doses to the maximally exposed member of the public from annual site operation at INEL range from 0.11 mrem for both the Full and the Phased APT with the helium-3 target option to 0.36 mrem for both the Large and Small ALWRs. From 40 years of operation, the corresponding risks of fatal cancer to this individual would range from $2.3 \times 10^{-6}$ to $7.3 \times 10^{-6}$. As a result of total site operation in the year 2030, the population doses would range from 23 person-rem for the Full and Phased APT to 73 person-rem for the Large ALWR. The corresponding numbers of fatal cancers in this population from 40 years of operation would range from 0.45 to 1.5.

The annual dose to the total site workforce would range from 250 person-rem for the MHTGR to 392 person-rem for the Large ALWR. The corresponding annual average doses to a site worker would be 31 mrem for the MHTGR and 49 mrem for the Large ALWR. The risks and numbers of fatal cancers among workers from 40 years of operation are included in table 4.2.3.9–1.

Based on the radiological impacts associated with normal operation as described above, all of the tritium supply technologies and recycling facilities are acceptable for siting at INEL. All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. The HIs to the maximally exposed individual of the public range from $1.8 \times 10^{-4}$ (MHTGR and APT) to $6.3 \times 10^{-4}$ (ALWR), whereas a cancer risk of 0 was calculated for all tritium supply technologies (table 4.2.3.9–2). The worker HIs range from 0.031 for HWR and 0.021 for MHTGR and APT to 0.13 for ALWR. There was no cancer risk for any other technology. All values are within the acceptable regulatory health limits. For details on the derivation of these HIs and

**TABLE 4.2.3.9–2.—*Potential Hazardous Chemical Impacts to the Public and Workers Resulting from Normal Operation at Idaho National Engineering Laboratory***

| | | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| **Health Impact** | **No Action** | **HWR[a,b]** | **MHTGR[a,b]** | **ALWR[a,b]** | **APT[a]** | **Tritium Recycling** |
| **Maximally Exposed Individual (Public)** | | | | | | |
| Hazard Index | $1.7 \times 10^{-4}$ | $2.1 \times 10^{-4}$ | $1.8 \times 10^{-4}$ | $6.3 \times 10^{-4}$ | $1.8 \times 10^{-4}$ | $5.4 \times 10^{-7}$ |
| Cancer risk | 0 | 0 | 0 | 0 | 0 | 0 |
| **Worker Onsite[c]** | | | | | | |
| Health Index | 0.021 | 0.031 | 0.021 | 0.13 | 0.021 | $4.9 \times 10^{-5}$ |
| Cancer risk | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Includes impacts from No Action.

[b] To determine the contribution from any of the tritium supply technologies, subtract the tritium recycling values for the Hazard Index or the cancer risk, respectively.

[c] The Hazard Index for the onsite worker is computed by using the permissible exposure level as the denominator rather than the reference concentration which is used for the maximally exposed member of the public (appendix E).

Note: Model results. See appendix table E.3.4–7.

cancer risks, see appendix tables E.3.4–2 through E.3.4–5 and summary table E.3.4–7.

*Tritium Supply Alone.*

Radiological Impacts. If the tritium recycling processes were not collocated with the tritium supply, the annual dose to the maximally exposed individual would decrease by 0.11 mrem, which is 0.031 percent of the dose from natural background radiation received by the average person near INEL. The estimated risk of fatal cancer to this individual would decrease by $2.2 \times 10^{-6}$ over 40 years of total site operation. Not collocating the tritium recycling processes at INEL would result in a decrease of 22 person-rem to the population within 50 miles in the year 2030, and 0.44 less fatal cancers over 40 years of operation.

If the tritium recycling processes were not collocated with the tritium supply, the average annual dose to an onsite worker would decrease by 4 mrem per year. In addition, the estimated risk of fatal cancer to this worker would decrease by $6.4 \times 10^{-5}$ over 40 years of site operation. The total annual workforce dose would decrease by 1.6 person-rem, resulting in 0.026 less fatal cancers over the 40 years.

Hazardous Chemical Impacts. If the tritium recycling processes were not collocated with the supply technologies at INEL, the cancer risk would not change since there is no cancer risk resulting from any option. The HIs to the public would be reduced by 0.3 percent or less and the HIs for the workers would be reduced by 0.02 percent or less. Based on the hazardous chemical impacts associated with normal operation at INEL all values are within regulatory health limits.

*Less Than Baseline Operations.*

Normal Operation. The normal operation radiological impacts for the HWR operating at reduced tritium production capacity to meet a less than baseline operation requirement would be proportional to the level of operation (approximately 50 percent of baseline). The MHTGR or ALWR normal operation radiological impacts would not change because the reactor would maintain power requirements to produce steam or electricity.

The Phased APT is already less than baseline tritium requirement and thus the impacts are as presently given in this PEIS.

*Potential Mitigation Measures.* Radioactive and hazardous chemical airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated and robotic production methods are examples of techniques that are being developed

which would reduce worker exposure. Substitution of less toxic/noncancer causing solvents would result in reductions of the HI and possible complete elimination of the cancer risk.

**Facility Accidents.**

*No Action.* The Idaho Chemical Processing Plant is being phased out and there are no other DOE defense program facilities in operation at INEL. As a result, under No Action, the risk of accidents at INEL would be unchanged from that reported in safety documentation for existing facilities.

*Tritium Supply and Recycling.* The proposed action at INEL has the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents have been assessed for each tritium supply technology and recycling facilities at INEL and are summarized in this section and described in more detail in appendix F. The methodology used in the assessment is described in section 4.1.9.

The potential impacts from accidents, ranging from high-consequence/low-probability to low-consequence/high-probability events, have been evaluated in terms of the number of cancer fatalities that may result. The risk of cancer fatalities has also been evaluated to provide an overall measure of an accident's impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities).

The analyses of postulated accidents for the tritium supply technology and recycling facilities at INEL indicate that, for the high consequence accident, the estimated risk of cancer fatalities to the public within 50 miles of the site would be $5.6 \times 10^{-6}$ cancer fatalities per year (table 4.2.3.9–3). This accident risk, which corresponds with the ALWR technology, is low when compared to the risk of cancer fatalities each year to the same population from all other causes.

Details on the range of accidents for the tritium supply technologies and recycling facilities at INEL are presented in appendix F. Each of the technologies has been analyzed from the standpoint of identifying the consequences of design basis/operational accidents (using the GENII Code) and beyond design basis, or severe accidents (using the MACCS computer code). The severe accident consequences are shown in table 4.2.3.9–3 for each technology. The table also shows the consequences of each accident for the population within 50 miles of the site and for an individual who may be located at the site boundary. The results of the analysis indicate that the tritium technology with the highest severe accident consequence is the ALWR. The technology with the lowest accident consequence is the APT with the helium-3 target system. These results take into account accidents that may occur in the tritium production system as well as the tritium extraction and recycling facilities. The tritium extraction and recycling facilities are common to all tritium supply technologies but, except for the APT, the consequences are dominated by reactor accidents. The APT accident consequences are lower than the tritium extraction facility's accident consequences.

Figure 4.2.3.9–1 shows the number of latent cancer fatalities that may result for each technology, including tritium extraction and recycling, if a high consequence accident were to occur. Specifically, each curve in the figure shows the conditional probability (vertical axis) that the number of cancer fatalities (horizontal axis) will be exceeded if the accident occurred. The curves do not reflect that probability of the accident.

The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be reduced; recreational areas may be closed; industrial parks may suffer economic losses; historic sites may have to be closed to visitors; and endangered species may move closer to extinction. In the region of the INEL, the natural background level of radiation (excluding radon) is 113 mrem per year. For a hypothetical design basis accidental release, the radiation levels exceeding 113 mrem per year would be well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $6.7 \times 10^{7}$ square meters (16,556 acres). Additional information on

**TABLE 4.2.3.9–3.—*Tritium Supply Technologies and Recycling High Consequence/Low Probability Radioactive Release Accidents and Consequences at Idaho National Engineering Laboratory***

| Parameter | Tritium Supply Technologies | | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
|---|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | | |
| | | | Large | Small | Full/Phased Helium-3 Target System[f,g] | Phased SILC Target System[h,i] | | |
| **Accident** | | | | | | | | |
| Frequency (per year) | $5.0\times10^{-8}$ | $6.0\times10^{-8}$ | $2.0\times10^{-8}$ | $2.0\times10^{-8}$ | $1.0\times10^{-4}$ | $1.0\times10^{-4}$ | $1.0\times10^{-6}$ | $1.0\times10^{-6}$ |
| **Consequence** | | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | | |
| Dose (rem) | 41 | $7.8\times10^{-2}$ | 166 | 149 | $1.3\times10^{-5}$ | $1.6\times10^{-4}$ | $3.9\times10^{-3}$ | 0.014 |
| Cancer fatalities | $9.9\times10^{-4}$ | $1.8\times10^{-6}$ | $3.7\times10^{-3}$ | $4.3\times10^{-3}$ | $1.9\times10^{-10}$ | $1.5\times10^{-9}$ | $2.3\times10^{-7}$ | $8.0\times10^{-7}$ |
| Risk (cancer fatalities per year) | $4.9\times10^{-11}$ | $1.1\times10^{-13}$ | $7.4\times10^{-11}$ | $8.6\times10^{-11}$ | $1.9\times10^{-14}$ | $1.5\times10^{-13}$ | $2.3\times10^{-13}$ | $8.0\times10^{-13}$ |
| ***Population Within 50 Miles*** | | | | | | | | |
| Dose (person-rem) | $1.3\times10^{5}$ | 226 | $4.6\times10^{5}$ | $5.7\times10^{5}$ | 0.018 | 0.10 | 23 | 81.0 |
| Cancer fatalities | 63 | 0.11 | 229 | 282 | $9.0\times10^{-6}$ | $5.0\times10^{-5}$ | 0.012 | 0.041 |
| Risk (cancer fatalities per year) | $3.2\times10^{-6}$ | $6.8\times10^{-9}$ | $4.6\times10^{-6}$ | $5.6\times10^{-6}$ | $9.0\times10^{-10}$ | $5.0\times10^{-9}$ | $1.2\times10^{-8}$ | $4.1\times10^{-8}$ |

[a] For detailed HWR accident discussion, see appendix section F.2.1.1

[b] For detailed MHTGR accident discussion, see appendix section F.2.1.2.

[c] For detailed ALWR accident discussion, see appendix section F.2.1.3.

[d] For detailed tritium target extraction facility discussion, see appendix section F.2.1.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.

[e] For detailed tritium recycling facility discussion, see appendix section F.2.3.

[f] For detailed APT with helium-3 target system discussion, see appendix section F.2.1.4.2.

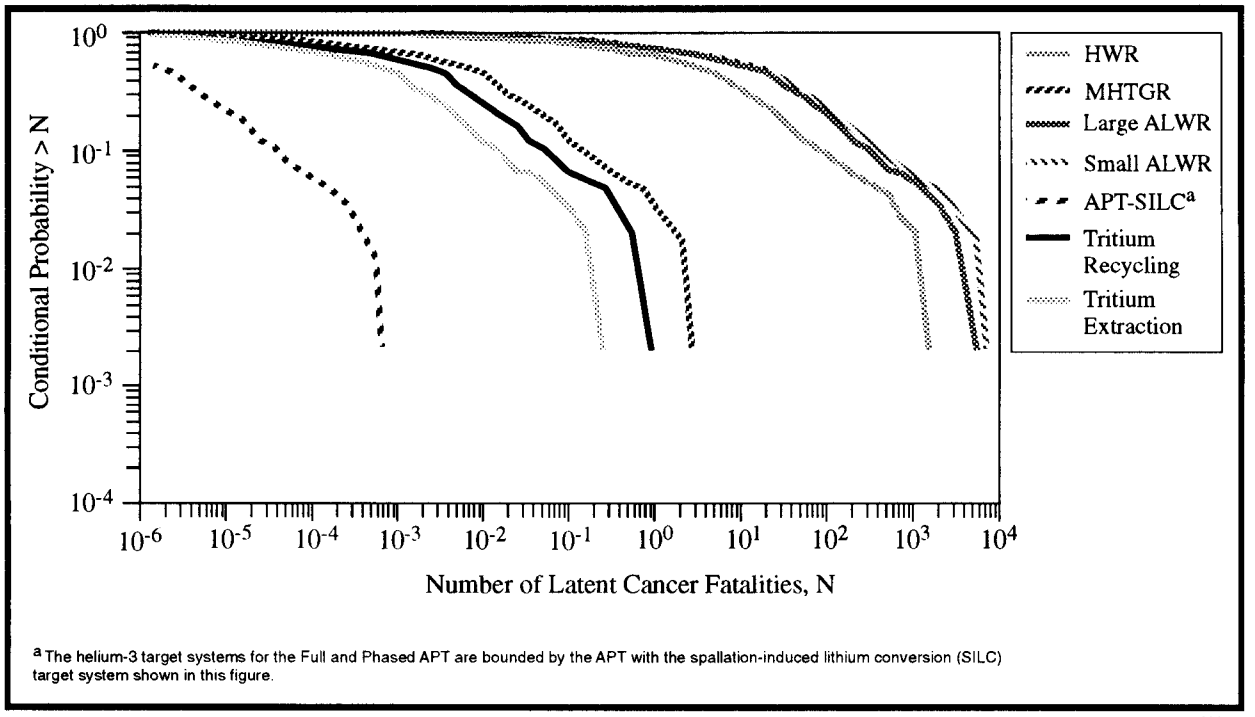
[g] Analysis postulated the total failure of the active emergency cooling system and the loss of the heat sink.

[h] For detailed APT with spallation-induced lithium conversion target system discussion, see appendix section F.2.1.4.3.

[i] Analysis postulated successful beam trip with the total failure of the active emergency cooling system.

Note: SILC - spallation-induced lithium conversion.

Note: Model results.




[a] The helium-3 target systems for the Full and Phased APT are bounded by the APT with the spallation-induced lithium conversion (SILC) target system shown in this figure.

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**FIGURE 4.2.3.9–1.—*High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Functions for Tritium Supply and Recycling Severe Accidents for Idaho National Engineering Laboratory.***

secondary impacts is provided in appendix section F.3.

*Tritium Supply Alone.* The analyses of reasonably foreseeable high consequence accidents for the tritium supply facilities at INEL are presented below.

Heavy Water Reactor. A set of accident sequences with a release category in which there is a reactor isolation failure with containment sprays failed was postulated as a high consequence accident for the HWR. In the event that this accident were to occur, there would be an estimated 63 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $9.9 \times 10^{-4}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is $3.2 \times 10^{-6}$ cancer fatalities per year (table 4.2.3.9–3).

Modular High Temperature Gas-Cooled Reactor. A set of accident sequences with a release category in which there is a depressurized conduction cooldown without the reactor cavity cooling system functioning was postulated. This would be a high consequence accident for the MHTGR. In the event that this accident were to occur, there would be an estimated 0.11 cancer fatalities in the population within 50 miles and increased likelihood of cancer fatality of $1.8 \times 10^{-6}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is $6.8 \times 10^{-9}$ cancer fatalities per year (table 4.2.3.9–3).

Advanced Light Water Reactor. A range of high consequence, low probability accidents with various release categories was selected to represent the accident consequences for both the Large and Small ALWRs (appendix section F.2.1.3). In the event of such an accident, there would be an estimated 229 cancer fatalities for a Large ALWR and 282 cancer fatalities for a Small ALWR in the population within 50 miles and an increased likelihood of cancer fatality of $3.7 \times 10^{-3}$ for a Large ALWR and $4.3 \times 10^{-3}$ for a Small ALWR to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is $4.6 \times 10^{-6}$ cancer fatalities per year for a Large ALWR and $5.6 \times 10^{-6}$ cancer fatalities per year for a Small ALWR (table 4.2.3.9–3).

Accelerator Production of Tritium with Helium-3 Target System. The large break loss of coolant accident with the total loss of the active emergency cooling system and the heat sink was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $9.0 \times 10^{-6}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.9 \times 10^{-10}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $9.0 \times 10^{-10}$ cancer fatalities per year (table 4.2.3.9–3).

Accelerator Production of Tritium with Spallation Induced Lithium Conversion Target System. The large break loss of coolant accident with a successful beam trip and the total loss of the active emergency cooling system was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $5.0 \times 10^{-5}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.5 \times 10^{-9}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $5.0 \times 10^{-9}$ cancer fatalities per year (table 4.2.3.9–3).

*Tritium Extraction and Recycling.* The tritium extraction facility is required to support all tritium supply technologies except the APT technology with the helium-3 target system. The tritium recycling facility is required to support all tritium supply technologies. The analyses of postulated high consequence accidents for the tritium extraction and recycling facilities at INEL are presented below.

Tritium Target Extraction Facility. An earthquake and release of process vessel tritium inventory was postulated as the high consequence accident. In the event that this accident were to occur, there would be an estimated 0.012 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $2.3 \times 10^{-7}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $1.2 \times 10^{-8}$ cancer fatalities per year.

Tritium Recycling Facility. An earthquake induced leak/ignition and fire in the unloading station carousel reservoir was postulated as the high consequence accident for the tritium recycling facility. In the event that this accident were to occur, there would be an estimated 0.041 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $8.0 \times 10^{-7}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $4.1 \times 10^{-8}$ cancer fatalities per year (table 4.2.3.9–3).

For comparison purposes, with high consequence tritium supply facility accidents, including extraction and recycling, for the same total population of 150,000 in the year 2050 in all sectors within 50 miles of the site, there is a risk of 300 cancer fatalities per year from all other natural causes.

The analysis of facility accidents for tritium supply at INEL shows that for high consequence accidents analyzed using the MACCS computer code, the ALWR has the highest consequences and risk and the APT has the lowest consequences and risk. The risk of accidents for any of the tritium supply alternatives, tritium extraction, and tritium recycling facilities common to all alternatives is low when compared to the human risk of cancer fatalities from all other causes.

The consequences of operational basis or design basis accidents for the tritium supply technology and recycling facilities at INEL are shown in table 4.2.3.9–4. The results in table 4.2.3.9–4 should not be compared with the severe accident analysis results in table 4.2.3.9–3 because different computer codes using different calculational approaches were used.

*Less Than Baseline Operations.*

Facility Accidents. Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the HWR unless the baseline HWR core design was downsized. The baseline HWR configuration would adjust to the reduced target through-put requirements by reducing the time that the reactor is required to operate at 100 percent power. It is not anticipated that the overall risk from operating the reactor in this mode would decrease significantly. Accident analyses have not

TABLE 4.2.3.9–4.—*Tritium Supply Technologies and Recycling Low to Moderate Consequence Radioactive Release Accidents and Consequences at Idaho National Engineering Laboratory*

| Parameter | Tritium Supply Technologies | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | |
| | | | Large | Small | Full/Phased | | |
| | | | | | SILC Target System[f] | | |
| **Accident** | | | | | | | |
| Description | Fuel assembly failure during charge and discharge operations | Large break in primary system piping | Large break loss of coolant accident | Large break loss of coolant accident | Large break loss of coolant accident[g] | Deflagration[h] | Hydride Bed Rupture |
| Frequency (per year) | 0.01 | 0.01 | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $2.0 \times 10^{-5}$ | $2.0 \times 10^{-4}$ |
| **Consequence** | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | |
| Dose (rem) | 0.020 | 0.022 | 5.1 | 0.23 | Negligible | 0.099 | $4.2 \times 10^{-4}$ |
| Cancer fatalities | $9.9 \times 10^{-6}$ | $1.1 \times 10^{-5}$ | $2.5 \times 10^{-3}$ | $1.1 \times 10^{-4}$ | Negligible | $5.0 \times 10^{-5}$ | $2.1 \times 10^{-7}$ |
| Risk (cancer fatalities per year) | $9.9 \times 10^{-8}$ | $1.1 \times 10^{-7}$ | $2.5 \times 10^{-6}$ | $1.1 \times 10^{-7}$ | Negligible | $1.0 \times 10^{-11}$ | $4.2 \times 10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | |
| Dose (person-rem) | 180 | 200 | $4.5 \times 10^{4}$ | $2.1 \times 10^{3}$ | Negligible | 990 | 4.1 |
| Cancer fatalities | 0.092 | 0.10 | 23 | 1.1 | Negligible | 0.5 | $2.1 \times 10^{-3}$ |
| Risk (cancer fatalities per year) | $9.2 \times 10^{-4}$ | $1.0 \times 10^{-3}$ | 0.023 | $1.1 \times 10^{-3}$ | Negligible | $1.0 \times 10^{-5}$ | $4.2 \times 10^{-7}$ |

[a] For detailed HWR accident discussion, see appendix section F.2.2.1.

[b] For detailed MHTGR accident discussion, see appendix section F.2.2.2.

[c] For detailed ALWR accident discussion, see appendix section F.2.2.3.

[d] For detailed tritium target extraction facility discussion, see appendix section F.2.2.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.

[e] For detailed tritium recycling facility discussion, see appendix section F.2.4.

[f] The APT with helium-3 target system bounding low to moderate consequence accident consequences are bounded by the APT with spallation-induced lithium conversion target system which are nil. For detailed APT discussion, see appendix section F.2.2.4.

[g] Analysis postulated all plant protection systems functioned as designed.

[h] Intense rapid burning.

Note: SILC - spallation-induced lithium conversion.

Note: Model results.

been performed to address accident sequences and initiating events when the reactor is in the cold shut down mode. In addition, operator error has a significant effect on facility risk and if the reactor is shutdown a high percentage of the time, operator error may actually increase when the reactor is at power.

Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the ALWR. The reactor surplus capacity would be used to generate steam for electric power production.

Less than baseline tritium operation would have no change to the MHTGR accident analyses because the analyses assumed that only one of the reactor modules would be involved in the accident.

Less than baseline tritium operation would have no significant change to the APT accident analyses consequences. The accident consequences for Full and Phased APT accidents with low to moderate consequences were negligible. For the beyond design basis accident, there was no difference in the Full and the Phased accident consequences. Review of the source terms is identical for both accidents. Review of the MACCS computer code output data for each accident analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results is negligible.

*Potential Mitigation Measures.* The accidents postulated for tritium supply technologies and recycling are based on operations and safety analyses that have been performed at similar facilities. One of the major design goals for tritium supply and recycling facilities is to achieve a reduced risk to facility personnel and to public health and safety to as low as reasonably achievable.

Worker exposures that may result from the accidental release of radioactive material will be minimized through design features and administrative procedures that will be defined in conjunction with the facility design process. The radiological impacts to workers from accidents could not be estimated for this PEIS because the facility design information needed to support the estimate has not yet been developed. The impacts on workers from accidents will be analyzed as part of subsequent project-specific NEPA documentation and in detailed safety analysis documentation that are prepared in conjunction with the facility design process.

The tritium supply and recycling facilities would be designed to comply with current Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide facilities that are highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, high wind, as well as credible events as appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity for containing materials.

The tritium supply and recycling facility would be designed to resist the effects of severe natural phenomena as well as the effects of man-made threats to its continuing structural integrity. It also would be designed to provide containment of the tritium inventory at all times through the use of multiple, high quality confinement barriers to prevent the accidental release of tritium to the environment. It also would be designed to produce a lower quantity of waste materials as compared to the tritium facilities of the existing weapons complex.

In addition, DOE orders specify the requirements for emergency preparedness at DOE facilities. INEL has comprehensive emergency plans to protect life and property within the facility and the health and welfare of surrounding areas. The emergency plans would be revised to incorporate future DOE requirements and expanded to incorporate the addition of tritium supply and recycling facilities to INEL. Section 4.2.2.9 provides additional information on emergency preparedness and emergency plans at INEL.

#### 4.2.3.10 *Waste Management*

Construction and operation of tritium supply and recycling facilities would impact existing INEL waste management operations by increasing the generation of low-level, mixed low-level, hazardous and nonhazardous wastes, and spent nuclear fuel. There are no high-level or TRU wastes associated with the proposed action. All reactor technologies would provide treatment and storage of spent fuel for the

life of the facility. Spent nuclear fuel would be managed in accordance with DOE's decisions identified in the ROD after completion of the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. The impacts of using existing waste management facilities would range from filling 15 acres per year of LLW disposal area, utilizing 100 percent of the capacity of the liquid LLW treatment facilities, increasing the generation of mixed LLW by a rate that would fill existing facilities in 84 percent of their planned lifetime, and producing solid sanitary wastes at a rate that would require additional landfill capacity. The worst case for solid hazardous waste generation increases the No Action volume by one-third, and would most likely require additional RCRA-permitted storage facilities where the waste could be staged for shipment to a RCRA-permitted disposal facility. All the tritium supply technologies and recycling facilities would produce liquid sanitary wastes that would require new treatment facilities because INEL does not have central facilities for this waste and there are no surface or subsurface discharge options. This section provides a description of the waste generation, treatment, storage and disposal requirements for the tritium supply technologies and recycling facilities and the potential impacts on waste management at INEL.

**No Action.** Under No Action, INEL has no weapons program mission; however, INEL may continue to receive spent nuclear fuel from naval reactors and would manage high-level, TRU, low-level, mixed, hazardous, and nonhazardous wastes from the missions described in section 3.3.1. Table 4.2.3.10–1 lists the projected waste generation rates; and treatment, storage, and disposal capacities under No Action. Projections were derived from 1992 environmental data with appropriate adjustments made for those changing operational requirements where the volume of wastes generated are identifiable. The projection does not include wastes from future, yet uncharacterized, environmental restoration activities. At the time that the new tritium supply and recycling facilities would be expected to commence operations (in the year 2010), much of the existing wastes at INEL would have been treated and disposed of or stored in compliance with existing regulations. The waste treatment activities that are planned to be still in operation are the calcination of liquid HLW and LLW after completion of the processing of special fuels and residuals at the Idaho Chemical Processing Plant, the retrieval and repackaging of buried TRU waste, and stabilization of spent nuclear fuel for long-term storage. Spent nuclear fuel would be managed in accordance with DOE's decisions identified in the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. TRU waste already packaged to WIPP waste acceptance criteria would either be stored or would have been shipped. Mixed waste would have been treated and disposed of according to the INEL Site Treatment Plan, which was developed to comply with the *Federal Facility Compliance Act* of 1992, and all other wastes currently identified would have been disposed of. The processing of these legacy wastes would require new facilities, since treatment, storage, and disposal facilities either do not exist or are nearing capacity.

**Tritium Supply and Recycling.** Tritium supply and recycling facilities that would support the nuclear weapons stockpile requirements (both new and existing facilities) would treat and package all waste generated in support of this activity into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2. The resultant waste effluents are shown in section 3.4. Waste generated during construction would consist of wastewater, nonhazardous solids, and hazardous waste. The nonhazardous wastes would be disposed of as part of the construction project by the contractor, and the hazardous wastes would be shipped to a RCRA-permitted treatment and disposal facility. Operation of the three reactor-based tritium supply technologies and recycling facilities would generate spent fuel, and all four technologies would generate low-level, mixed low-level, hazardous, and nonhazardous wastes. The volume of the waste streams from tritium supply would vary according to the technology chosen. Table 4.2.3.10–2 lists the total estimated waste volumes projected to be generated at INEL as a result of tritium supply technologies and recycling facilities. The incremental waste volumes from the tritium supply and recycling facilities that were added to the No Action projection can be found in

**TABLE 4.2.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management Under No Action at Idaho National Engineering Laboratory* [Page 1 of 2]**

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None (offsite receipts being evaluated) | Stabilization | Being designed | Pools, dry, casks | Planned[a] | Planned - Federal repository | NA |
| **High-Level** | | | | | | | |
| Liquid | 981 (198,162 gal) | Calcine | 1,308 (264,216 GPY) | Tanks | 16,101 (3,252,000 gal) | None | None |
| Solid | 1,439 | Under development | To be designed | Bins | 9,267 | Planned - Federal repository | NA |
| **Transuranic** | | | | | | | |
| Liquid | None | None | None | None | None | NA | NA |
| Solid | < 1 | Planned | Planned | TRU storage facility | Planned | Planned - Federal respository | NA |
| **Low-Level** | | | | | | | |
| Liquid | None[b] | Evaporation, fractionation | 14,376[c] (2,904,000 GPY) | Tanks | 47,160 | NA | NA |
| Solid | 5,101 | Incineration, compact | 64,910[d] | None | None | Subsurface disposal | 235,345 |
| **Mixed Low-Level** | | | | | | | |
| Liquid | None | Incineration, stabilize | 64,910 (13,110,000 GPY) | Facility | 65,580 (13,245,000 gal) | None | None |
| Solid | 655 | Incineration, stabilize | 64,910 | Facility | 147,759 | LLW burial | 235,345 |
| **Hazardous** | | | | | | | |
| Liquid | None | Incineration | 64,910 (13,110,000 GPY) | Drums, RCRA facility | 127 (25,650 gal) | None | None |
| Solid | 308 | Incineration | 64,910 | RCRA facility | 119 | RCRA facility | Planned[a] |

**TABLE 4.2.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management Under No Action at Idaho National Engineering Laboratory* [Page 2 of 2]**

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | Included in solid | Evaporation | Planned | Ponds | Planned | None | None |
| Solid | 68,000 | None | Planned | None | None | Landfill | Planned[a] |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | None | None | NA | NA | NA | NA | NA |
| Solid | Included in sanitary | None | NA | None | None | Onsite landfill | Planned[a] |

[a] Long-term storage and capacity planned pending ROD from *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs EIS.*

[b] No new waste. Process wastewater from legacy waste.

[c] One-shift operation.

[d] Permitted capacity. Typically 3,900 $yd^3$/yr.

Note: NA - not applicable

Source: DOE 1993a; DOE 1993b; DOE 1993o; DOE 1993r: DOE 1993s; DOE 1993t; IN DOE 1992b; IN DOE 1992c; IN DOE 1993a; IN MMES 1993a; INEL 1993a:5.

appendix section A.2. Requirements for LLW disposal that would result from each of the tritium supply technologies assume the effluents listed in this appendix section and in section 3.4. Table 4.2.3.10–3 lists potential waste management impacts at INEL projected at the time of initial operation of the tritium facilities. Spent nuclear fuel storage for the life of the reactors is provided for in the reactor designs (appendix section A.2.1). The interim management of spent nuclear fuel (pending the availability of a geologic repository) would be in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. Because spent nuclear fuel reprocessing is not planned, no HLW would be generated. Without plutonium production, no TRU waste would be generated. The treatment, storage, and disposal of mixed LLW would be in accordance with the INEL Site Treatment Plan which is currently being developed pursuant to the *Federal Facility Compliance Act* of 1992.

*Heavy Water Reactor.* Spent nuclear fuel would be generated at the rate of 7 $yd^3$ per year. The HWR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the HWR would require treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides and prepare the solidified waste for disposal onsite. The generation of solid LLW would be increased to a rate that is more than twice the No Action volume. Assuming a 3,600 $ft^3$ per acre LLW disposal usage factor, this would require approximately 15 acres per year for onsite LLW disposal. There would be a small amount of liquid mixed LLW generated. Existing and planned treatment facilities could manage this small quantity. The solid mixed LLW volume would increase 19 percent over No Action, resulting in a proportional increase in the volume to be treated and stored at INEL. Hazardous waste would increase by 13 percent more than the No Action volume treated and stored. This would require a RCRA-permitted storage facility where the waste could be packaged for shipment to a RCRA-permitted treatment and disposal facility. Liquid sanitary wastes generated by the HWR would require new treatment facilities since INEL does not have centralized facilities for these wastes. The volume of solid sanitary wastes would increase the amount to be disposed of by 22 percent more than No Action. This could reduce the remaining useful life of the landfill or require an expansion.

Siting an HWR without tritium recycling facilities at INEL would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.2.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from 22 percent to 11 percent; thus proportionately decreasing the impact to the landfill.

*Modular High Temperature Gas-Cooled Reactor.* Spent fuel would be generated at the rate of 80 $yd^3$ per year. The MHTGR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. There would be liquid LLW generation, requiring a treatment facility. Solid LLW generation at INEL would increase to a rate 32 percent greater than No Action. It would be treated and disposed of onsite, requiring 4 acres per year of LLW disposal. There would be some liquid mixed LLW generation from tritium recycling, and the solid mixed LLW generation would cause the rate to increase by less than 1 percent above No Action. Thus, there would be a minor impact from this waste stream. The MHTGR would generate hazardous waste, increasing the volume to by 33 percent more than that under No Action. This would require a permitted storage facility where the waste could be staged for shipment to a RCRA-permitted treatment and disposal facility. Liquid sanitary wastes generated by the MHTGR would require new treatment facilities since INEL does not have centralized facilities for these wastes. The volume of solid sanitary wastes disposed of at INEL would be increased by 22 percent more than No Action. This could reduce the remaining life of the landfill or require an expansion.

TABLE 4.2.3.10–2.—*Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory*[a]

| Category | No Action ($yd^3$) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR ($yd^3$) | MHTGR ($yd^3$) | ALWR/Large ($yd^3$) | ALWR/Small ($yd^3$) | APT[b] ($yd^3$) |
| **Spent Nuclear Fuel** | None (offsite receipts being evaluated) | 7 | 80 | 30 | 15 | None |
| **Low-Level** | | | | | | |
| Liquid | None | 10,400 (2,100,000 gal) | 2,600 (525,000 gal) | 24,800 (5,000,000 gal) | 3,910 (790,000 gal) | None |
| Solid | 5,100 | 10,700 | 6,750 | 6,160 | 6,110 | 5,990 |
| **Mixed Low-Level** | | | | | | |
| Liquid | None | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) |
| Solid | 655 | 777 | 658 | 663 | 663 | 664 |
| **Hazardous** | | | | | | |
| Liquid | None | Included in solid | Included in solid | Included in solid | Included in solid | None |
| Solid | 308 | 349 | 409 | 344 | 344 | 312 |
| **Nonhazardous (Sanitary)** | | | | | | |
| Liquid | Included in solid | 309,000 (62,300,000 gal) | 219,000 (44,300,000 gal) | 516,000 (104,000,000 gal) | 318,000 (64,300,000 gal) | 2,060,000 (416,000,000 gal) |
| Solid | 68,000 | 83,000 | 82,800 | 82,300 | 79,600 | 76,600 |
| **Nonhazardous (Other)** | | | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 12,900[c] | 12,800[c] | 12,200[c] | 9,900[c] | 6,400[c] |

[a] The No Action waste volumes are from table 4.2.3.10–1. Waste volumes for tritium supply and recycling options were derived by adding the waste volumes of the various tritium supply and recycling options found in appendix section A.2 (tables A.2.1.1–4, A.2.1.2–4, A.2.1.3–4, A.2.1.3–5, A.2.1.4–4, and A.2.2.1–4) to the No Action volumes. Waste volumes have been rounded to three significant figures.

[b] The APT and recycling waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target waste volumes are approximately the same with the exception of solid LLW which is 5,520 $yd^3$.

[c] Recyclable wastes.

**TABLE 4.2.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory* [Page 1 of 2]**

| | Tritium Supply Technologies and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Spent Nuclear Fuel** | New | New storage facility | New | New storage facility | New | New storage facility | New | New storage facility | None | None |
| **Low-Level** | | | | | | | | | | |
| Liquid | New | May be able to use existing facility | New | May be able to use existing facility | New | New treatment facility required | New | May be able to use existing facility | None | None |
| Solid | +109 | 15 acres/ year of LLW disposal required | +32 | 4 acres/year of LLW disposal required | +21 | 5 acres/year of LLW disposal required | +20 | 3 acres/year of LLW disposal required | +18 | 3 acres/year of LLW disposal required |
| **Mixed Low-Level** | | | | | | | | | | |
| Liquid | New | None | New | None | New | None | New | None | New | None |
| Solid | +19 | Additional or expansion of treatment and storage facilities may be required | +<1 | None | +1 | None | +1 | None | +1 | None |
| **Hazardous** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +13 | Use of existing facilities feasible | +33 | Use of existing facilities feasible | +12 | Use of existing facilities feasible | +12 | Use of existing facilities feasible | +1 | Use of existing facilities feasible |

TABLE 4.2.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory* [Page 2 of 2]

| | Tritium Supply Technologies and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Nonhazardous (Sanitary)** | | | | | | | | | | |
| Liquid | New | New treatment facilities required | New | New treatment facilities required | New | New treatment facilities required | New | New treatment facilities required | New | New treatment facilities required |
| Solid | +22 | Landfill life reduced or expansion required | +22 | Landfill life reduced or expansion required | +21 | Landfill life reduced or expansion required | +17 | Landfill life reduced or expansion required | +13 | Landfill life reduced or expansion required |
| **Nonhazardous (Other)** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +19 percent of sanitary | None-Project wastes are recyclable | +19 percent of sanitary | None-Project wastes are recyclable | +18 percent of sanitary | None-Project wastes are recyclable | +15 percent of sanitary | None-Project wastes are recyclable | +9 percent of sanitary | None-Project wastes are recyclable |

[a] This column reflects the percentage change in generation rate over No Action. Percentage change was calculated using waste volumes prior to rounding. Do not use rounded numbers in table 4.2.3.10–2 to calculate percentage change.

Source: Tables 4.2.3.10–1 and 4.2.3.10–2.

Siting an MHTGR without tritium recycling facilities at INEL would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.2.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from 22 percent to 11 percent, thus proportionately decreasing the impact to the landfill.

*Advanced Light Water Reactor (Large).* Spent nuclear fuel would be generated at the rate of 30 $yd^3$ per year. The Large ALWR would be designed to provide the necessary treatment and storage for the spent fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require new treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides to prepare the waste for disposal onsite. The volume of these wastes from the Large ALWR is the largest of all the technologies and exceeds the capacity of the Liquid Effluent Treatment Facility (appendix table H.2.1–5). The solid LLW volume would increase the rate disposed of at INEL by 21 percent more than the No Action volume. This would require 5 acres per year of onsite LLW disposal. There would be a small amount of liquid mixed LLW generated. The ALWR solid mixed LLW generation would cause the rate at INEL to increase only 1 percent above No Action, so there would be a small impact from this waste stream. Hazardous waste generation would increase by 12 percent over No Action. This would require a RCRA-permitted facility to prepare the waste for shipment to a RCRA-permitted treatment and disposal facility. Liquid sanitary wastes generated by the Large ALWR, are larger in volume than the other technologies, and would require new treatment facilities since INEL does not have centralized facilities for these wastes. The solid sanitary wastes generated by the ALWR would increase the disposal at INEL by 21 percent more than No Action generation. This could reduce the remaining useful life of the landfill or require an expansion.

Siting a Large ALWR without tritium recycling facilities at INEL would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.2.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from 21 to 10 percent, thus proportionately decreasing the impact to the landfill.

*Advanced Light Water Reactor (Small).* Spent nuclear fuel would be generated at the rate of 15 $yd^3$ per year. The Small ALWR would be designed to provide the necessary treatment and storage for the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides to prepare the waste for disposal onsite. The solid LLW volume would require 3 acres per year of onsite LLW disposal. There would be a small amount of liquid mixed LLW generated. The ALWR solid mixed LLW generation would cause the rate at INEL to increase by only 1 percent above No Action, so there would be a small impact from this waste stream. Hazardous waste generation would increase by 12 percent over No Action. This would require a RCRA-permitted facility to prepare the waste for shipment to a RCRA-permitted treatment and disposal facility. Liquid sanitary wastes generated would require new treatment and disposal facilities because INEL does not have centralized facilities for these wastes. The solid sanitary wastes generated would increase by 17 percent more than No Action generation. This could reduce the remaining useful life of the landfill or require an expansion.

Siting a Small ALWR without tritium recycling facilities at INEL would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid

mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.2.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from 17 to 6 percent; thus proportionately decreasing the impact to the planned lifetime of the landfill.

*Accelerator Production of Tritium.* The APT does not generate spent nuclear fuel. Any liquid LLW can be solidified at the point of generation. The APT-generated solid LLW would increase the volume disposed of at INEL by 18 percent more than No Action. This would require 3 acres per year of onsite LLW disposal. Liquid and solid mixed LLW would be 1 percent of No Action, having a small impact. Hazardous waste generation would also increase by 1 percent more than No Action, resulting in a small impact. Existing/planned RCRA-permitted facilities where it could be staged for shipment to an onsite commercial RCRA-permitted treatment and disposal facility would be adequate. Liquid sanitary wastes generated by the APT would require new treatment facilities since INEL does not have centralized facilities for these wastes. The generation of solid sanitary wastes would increase by 13 percent. This could reduce the remaining useful life of the landfill or require an expansion.

Siting an APT without tritium recycling facilities at INEL would not affect the generation of nor change the impacts from liquid LLW as described above and in table 4.2.3.10–3. Liquid mixed LLW would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid nonhazardous wastes would not change from those described above and in table 4.2.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from 13 to less than 2 percent. Therefore, without tritium recycling facilities, there is minimal impact to the landfill.

*Less Than Baseline Operations.* In the event of a reduced baseline tritium requirement the waste volumes shown in table 4.2.3.10–2 would not appreciably change as a result of the HWR operating at less power, and the MHTGR and ALWR irradiating fewer target rods. In the case of a Phased APT using the helium-3 target, the waste volumes are approximately the same as the Full APT using the helium-3 target.

**Potential Mitigation Measures.** Each tritium supply technology and recycling facility would be designed to process its own waste into forms suitable for storage or disposal and would use proven waste minimization and pollution prevention technologies to the extent possible. Some facility designs would produce waste quantities or waste forms that could undergo additional reductions by utilizing emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be major factors in determining the final design of any facility constructed as part of the proposed action at INEL. Pollution prevention and waste minimization would also be analyzed as part of the site-specific analyses and tiered NEPA documents.

Utilization of existing treatment, storage, and disposal facilities described in sections 4.2.2.10 and appendix section H.2.1 could further reduce impacts. For instance, the liquid LLW processing facilities at the Idaho Chemical Processing Plant have capacity exceeding the generation rate of the HWR, and may have the potential to process those wastes. Similarly, the Waste Experimental Reduction Facility may have the capacity to treat LLW, mixed LLW, and hazardous wastes from the new tritium supply and recycling facilities. The use of existing incineration at INEL could reduce the volume of solid LLW to be disposed by a factor of up to 80. It would be possible to utilize centralized disposal facilities for solid LLW and solid sanitary, and industrial nonhazardous wastes. Utilization of these facilities would require site-specific engineering studies and NEPA analysis.

## 4.3 NEVADA TEST SITE

NTS was established in 1950 and currently occupies approximately 864,000 acres located 65 miles northwest of Las Vegas, NV. The site has conducted underground testing of nuclear weapons and evaluation of the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. In October 1992, underground nuclear testing was halted, yet the site maintains the capability to resume testing if authorized by the President. Section 3.3.3 provides a description of all the DOE missions and support facilities at NTS. The location of NTS within the State of Nevada is illustrated in figure 4.3–1.

### 4.3.1 Description of Alternatives

Under the proposed action, any one of the four tritium supply technologies (HWR, MHTGR, ALWR, or APT) alone or collocated with a new tritium recycling facility could be sited at NTS. Section 3.4.2 provides a description of the tritium supply technologies and section 3.4.3.1 describes the tritium recycling facility. Figure 4.3.1–1 shows the location of existing facilities within NTS and the TSS.

Under No Action, NTS would continue its current and planned missions as described in section 3.3.3. Even though a moratorium has been placed on all underground nuclear testing, NTS will still be required to maintain the capability to resume such testing in the event it is again required for national security. No facilities at NTS would be phased out as a result of any of the proposed action alternatives discussed in this PEIS.

### 4.3.2 Affected Environment

The following sections describe the affected environment at NTS for land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, NTS's infrastructure, radiation and hazardous chemical environment, and the waste management conditions are described.

#### 4.3.2.1 *Land Resources*

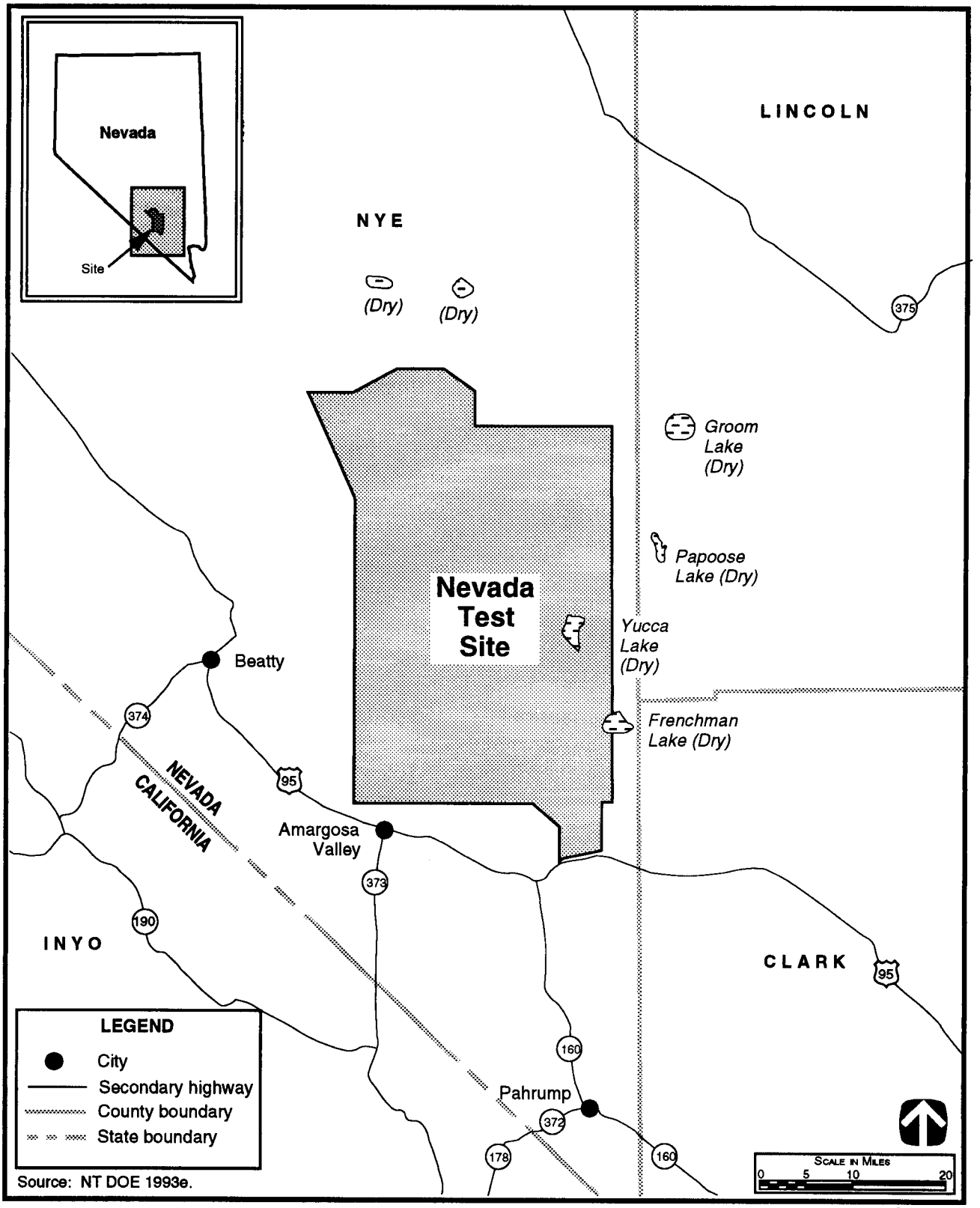
The discussion of land resources at NTS includes land use and visual resources.

**Land Use.** NTS occupies approximately 864,000 acres in southern Nye County in southern Nevada, with the southwestern boundary located approximately 10 miles from California. The town of Indian Springs and Indian Springs Air Force Base, in northeast Clark County, NV, are 24 miles southeast of the closest NTS boundary. All of the land within NTS is owned by the Federal government and is administrated, managed, and controlled by DOE. NTS is also entirely bordered by Federal land; the land on the west, north, and east consists of the Nellis Air Force Range. The Federal land to the south is administered by the Bureau of Land Management.

Generalized land uses at NTS and its vicinity are shown on figure 4.3.2.1–1. NTS is divided into three major regions consisting of 26 areas. The north region of NTS is the underground nuclear weapons test area. Nuclear test ranges are located at Yucca Flats, Pahute Mesa, Rainier Mesa, and Buckboard Mesa. The southwest region of NTS (Area 25) provides support for nonweapons and nonnuclear weapons programs, such as the proposed high-level waste repository at Yucca Mountain Project Site, and for short-term activities such as the Nuclear Weapons Accident Exercises conducted by the Nuclear Emergency Search Team. The southeast region is the nonnuclear explosives test area and primary administrative and support area of NTS.

Land not used for missions or other purposes has been designated in the NTS Site Development Plan as reserve areas, available for future development. Approximately 100,000 acres of reserve areas are present within Areas 5 and 6, located in Frenchman and Yucca Flats.

As shown on figure 4.3.2.1–1, the proposed 600-acre TSS would be located within the northwest portion of Frenchman Flat. This is currently an undeveloped reserved area, with the exception of the closed Cane Spring Test Range and the combined Device Assembly Facility. The Device Assembly Facility, undergoing final construction, is designed to conduct all nuclear assembly operations at NTS in support of the Nuclear Weapons Test Program. Other nearby




Source: NT DOE 1993e.

5098-NTS/001

**FIGURE 4.3–1.**—*Nevada Test Site, Nevada, and Region.*

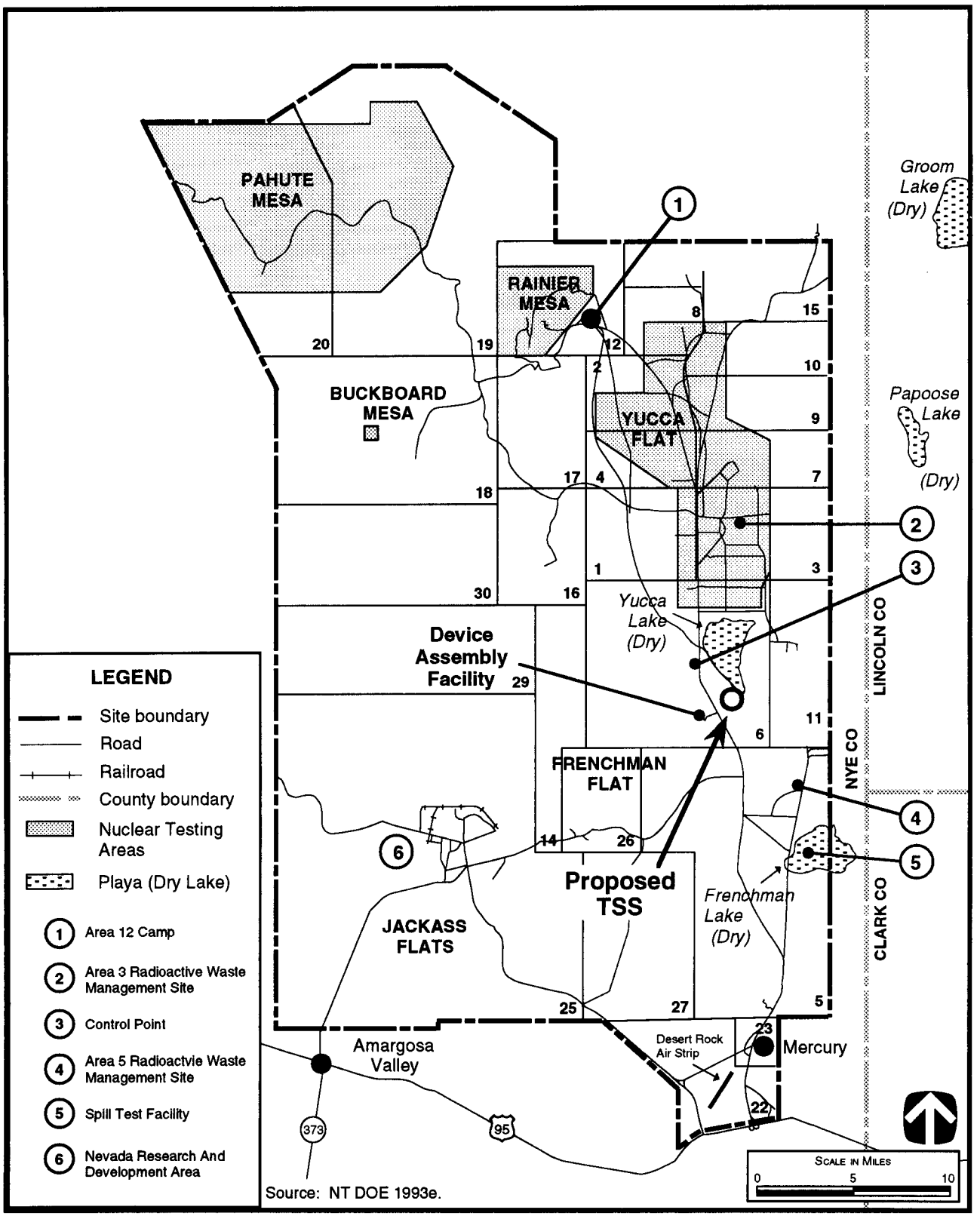



**FIGURE 4.3.1–1.**—***Primary Facilities, Proposed Tritium Supply Site, and Testing Areas at Nevada Test Site.***

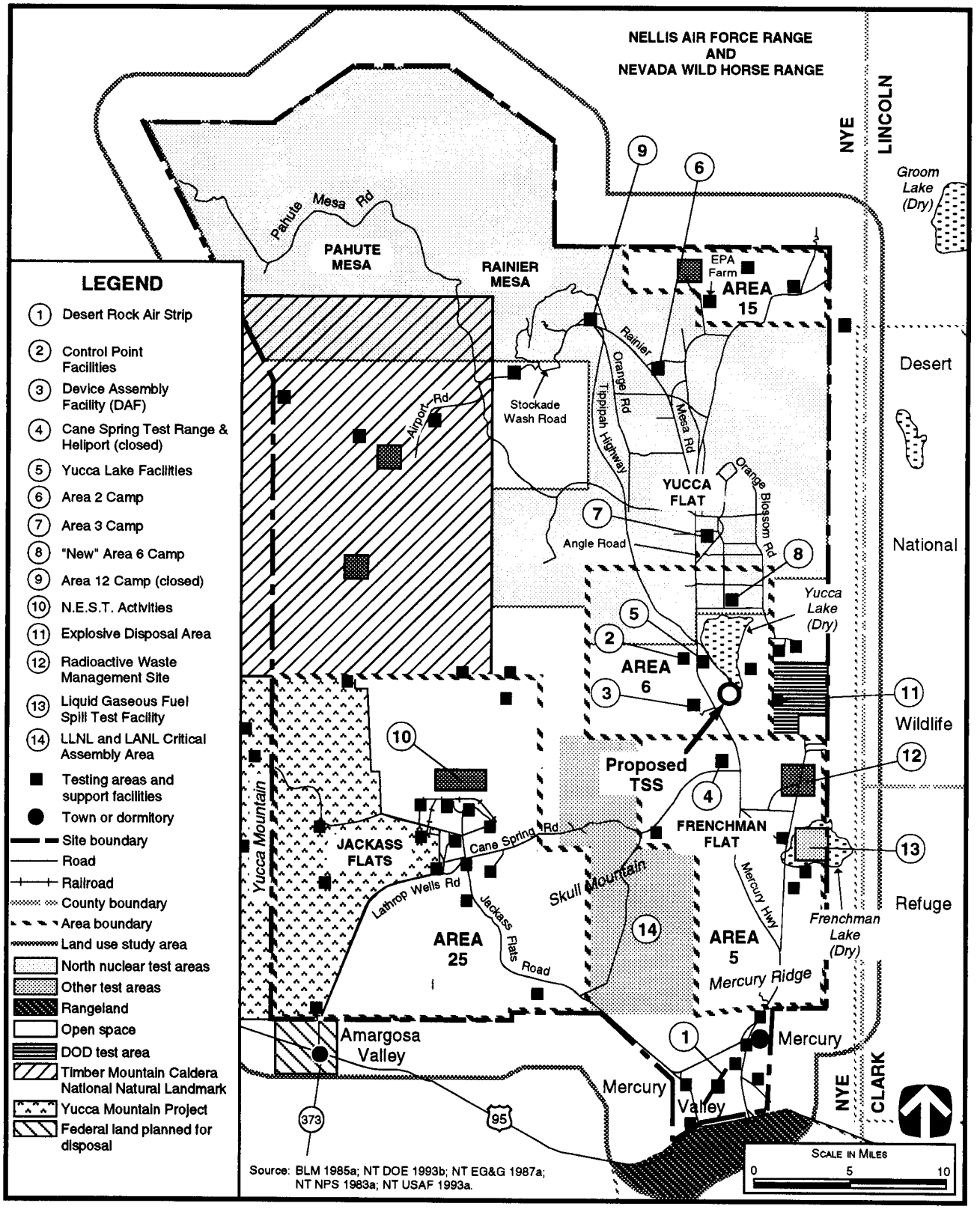



**FIGURE 4.3.2.1–1.**—***Generalized Land Use at Nevada Test Site and Vicinity.***

facilities are the DOD Test Area, Explosives Disposal Area, Radioactive Waste Management Site, and Liquid Gaseous Fuel Spill Test facility.

In 1992, DOE designated all but approximately 67,800 acres of NTS as a National Environmental Research Park. The National Environmental Research Park is used by the national scientific community as an outdoor laboratory for research on the effects of human activities on the desert ecosystem. There is no prime farmland present on NTS. Past agricultural activities consisted of the EPA Farm in Area 15, an agricultural crop and animal radiological research facility, which closed in 1981. Offsite agricultural activity occurs on the south side of U.S. Route 95, consisting of a cattle allotment granted by the Bureau of Land Management.

The Timber Mountain Caldera National Natural Landmark is located approximately 8 miles north northwest of the TSS, separated by mountains to the west. A wilderness study area located within the Desert National Wildlife Refuge, which has been recommended for inclusion into the National Wilderness System, is approximately 6 miles east of the TSS. This part of the refuge is also a part of the Nellis Air Force Range; it is jointly managed by the U.S. Air Force and USFWS. Public entry to this portion of the refuge is generally prohibited by the Air Force.

The closest offsite residence to the NTS boundary is 1.3 miles south, at the unincorporated town of Amargosa Valley.

**Visual Resources.** The low-lying valleys and flats of NTS are surrounded by mountains typical of the Basin and Range Province. The vegetation is typical of the Great Basin Desert. The visible facilities of NTS are scattered in this desert setting.

Public viewpoints of NTS are located in the Amargosa Valley and Mercury Valley along U.S. Route 95, the principal highway between Tonopah and Las Vegas. The principal viewpoint in the Mercury Valley is a roadside turnoff containing Nevada Historical Marker No. 165 of the Nevada State Park System, entitled "Nevada Test Site." NTS facilities within 5 miles are visible from this viewpoint. The testing areas of NTS, including the TSS, are not visible from the road because of mountainous terrain and distance. The main base camp at Mercury (approximately 4 miles away) is well defined at night by facility lighting, surrounded by the dark desert and night sky. The mix of industrial use and open desert is consistent with a VRM Class 4 designation.

There are viewpoints of the TSS from Buried Hills, Frenchman Flat, Spotted Range, Ranger Mountains, and Mercury Ridge in the wilderness study area of Desert National Wildlife Refuge. Access to this area of the Desert National Wildlife Refuge is controlled by the U.S. Air Force. The views from this wilderness study area and wildlife refuge are typical of the Basin and Range Province. Land disturbances from human activity can be seen but are not evident and do not attract attention consistent with a VRM Class 2 designation.

#### 4.3.2.2 *Site Infrastructure*

As shown in figure 4.3.2.1–1, activities at NTS are concentrated in facilities in several general areas. Section 3.3.3 describes the current missions. To support these missions an infrastructure exists as shown in table 4.3.2.2–1. Of critical importance to the proposed action is the electrical power infrastructure at the proposed TSS. The regional electrical power pool area in which NTS is located and from which it draws its power is the California-Southern Nevada Power Area. Characteristics of this power pool are listed in table 4.3.2.2–2.

**TABLE 4.3.2.2–1.— *Baseline Characteristics for Nevada Test Site***

| Current Characteristics | Value |
|---|---|
| **Land** | |
| Area (acres) | 864,000 |
| Roads (miles) | 400 |
| Railroads (miles) | 0 |
| **Electrical** | |
| Energy consumption (MWh/yr) | 168,500 |
| Peak load (MWe) | 28 |
| **Fuel** | |
| Natural gas ($ft^3$/yr) | 0 |
| Oil (GPY) | 1,510,000 |
| Coal (ton/yr) | 0 |
| **Steam** (lb/hr) | 0 |

Source: NTS 1993a:4.

**TABLE 4.3.2.2–2.—*Regional Power Pool Electrical Summary for Nevada Test Site***

| Type Fuel | Production (percent) |
|---|---|
| Coal | 14 |
| Nuclear | 15 |
| Hydro/geothermal | 19 |
| Oil/gas | 22 |
| Other[a] | 30 |
| **Total Annual Production:** 246,012,000 MWh | |
| **Total Annual Load:** 293,262,000 MWh | |
| **Energy Imported Annually[b]:** 45,400,000 MWh | |
| **Generating Capacity:** 61,681 MWe | |
| **Peak Demand:** 57,028 MWe | |
| **Capacity Margin[c]:** 11,809 MWe | |

[a] Includes power from both utility and nonutility sources.
[b] Energy imported is not the difference of production and load due to positive net pumped storage.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

### 4.3.2.3 *Air Quality and Acoustics*

The following describes the existing air quality and acoustics at NTS, and includes a review of meteorology and climatology and atmospheric dispersion characteristics in the vicinity of NTS. More detailed discussions of air quality and acoustics methodologies and input data are presented in appendix section B.1.3.3.

**Meteorology and Climatology.** The climate at NTS and in the surrounding region is characterized by limited precipitation, low humidity, and large diurnal temperature ranges. The lower elevations are characterized by hot summers and mild winters, which are typical of other Great Basin desert areas. As elevation increases, precipitation amounts increase and temperatures decrease (NT DOE 1986b).

The average daily temperatures at NTS, based upon the mean of the daily minimum and maximum temperature, range from 44.5 °F in January to 89.8 °F in July. The annual average temperature calculated from these average daily temperatures is 66 °F. The average annual precipitation at NTS ranges from 6 to 9 inches (NT DOC 1968a). Prevailing winds at NTS vary by location. Additional information related to meteorology and climatology at NTS is presented in appendix section B.1.3.3.

**Ambient Air Quality.** NTS is located within the Nevada AQCR 147. The region is in attainment with respect to the NAAQS for criteria pollutants (40 CFR 50). Applicable NAAQS and Nevada State ambient air quality standards are presented in appendix table B.1.3.1–1.

Two Prevention of Significant Deterioration Class I areas in the vicinity of NTS are Grand Canyon National Park, approximately 120 miles to the southeast, and Sequoia National Park, California, approximately 105 miles to the west-southwest.

The primary emission sources of criteria air pollutants at NTS include particulates from construction and other surface disturbances, fugitive dust from unpaved roads, various pollutants from fuel burning equipment, incineration, open burning, and volatile organics from fuel storage facilities. A summary of emission estimates for sources at NTS is presented in appendix table B.1.3.3–2.

Table 4.3.2.3–1 shows the site baseline ambient air concentrations for criteria pollutants and other pollutants of concern at NTS. With the exception of the 24-hour $PM_{10}$ and TSP standards, baseline concentrations are in compliance with applicable guidelines and regulations. The 24-hour $PM_{10}$ and TSP standards are exceeded due to moderate background concentrations and contributions from operations at the site. The nearest ambient air quality monitor operated by the State of Nevada is in Nye County (appendix table B.1.3.3–1). Elevated levels of ozone ($O_3$) or particulates ($PM_{10}$ and TSP) may occur occasionally because of pollutants transported into the area by wind or because of local sources of fugitive particulates (NT DOE 1983a). Concentrations of other criteria pollutants ($SO_2$, $NO_2$, CO, and lead (Pb)) are low because there are no large emission sources nearby. The nearest significant emission source for criteria pollutants is the Las Vegas area, which is about 65 miles southeast of NTS.

**Acoustic Conditions.** Major noise emission sources within NTS include various industrial facilities, equipment and machines, and aircraft operations. Noise survey data at NTS are unavailable. At the site

**TABLE 4.3.2.3–1.—*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Nevada Test Site, 1990-1992***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Baseline Concentration ($\mu g/m^3$) |
|---|---|---|---|
| **Criteria Pollutant** | | | |
| Carbon monoxide (CO) | 8-hour | 10,000[a] | 2,290 |
| | 1-hour | 40,000[a] | 2,748 |
| Lead (Pb) | Calendar Quarter | 1.5[a] | [b] |
| Nitrogen dioxide ($NO_2$) | Annual | 100[a] | [b] |
| Ozone ($O_3$) | 1-hour | 235 | [b] |
| Particulate matter[c] ($PM_{10}$) | Annual | 50[a] | 8.4 |
| | 24-hour | 150[a] | 172.6 |
| Sulfur dioxide ($SO_2$) | Annual | 80[a] | 6.9 |
| | 24-hour | 365[a] | 117 |
| | 3-hour | 1,300[a] | 660.6 |
| **Mandated by Nevada** | | | |
| Total suspended particulates (TSP) | Annual | 75[d] | 8.4 |
| | 24-hour | 150[d] | 172.6 |
| **Hazardous and Other Toxic Compounds** | | | |
| No sources | [e] | [e] | [e] |

[a] Federal standard (40 CFR 50).
[b] Not measured.
[c] It is assumed that $PM_{10}$ data are TSP data.
[d] State standard.
[e] No sources indicated.
Source: DOE 1992k; NT REECO 1990a.

boundary, away from most of the industrial facilities at NTS, noise emitted from the site is barely distinguishable from background noise levels.

The acoustic environment around NTS can be classified as either uninhabited desert or small rural communities. Wind is the predominant source of noise. Except for the prohibition of nuisance noise, neither the State of Nevada nor its local governments have established specific numerical environmental noise standards applicable to NTS.

### 4.3.2.4 *Water Resources*

This section describes the surface water and groundwater resources at NTS.

**Surface Water.** There are no continuously flowing streams on NTS. The most noticeable natural hydrologic features of NTS are the playas (lake beds) that collect stormwater runoff. Runoff in the eastern half of the site ultimately collects in the playas of Yucca Flat and Frenchman Flat. In the northeastern portion the runoff drains outside the test site and onto the Nellis Air Force Range Complex. In the western half and southernmost part, runoff is carried offsite towards the Armagosa Desert. Figure 4.3.1–1 shows the location of the playas and flats. A few natural springs can be found at NTS. Surface water is not used at NTS (NT DOE 1992d).

Because there are no continuously flowing surface waters there are no studies to assess 500-year floodplain boundaries, although a 100-year flood analysis has been conducted. This analysis showed that the runoff from a 100-year storm could potentially flow through Jackass Flats, which is well south and west of the proposed TSS (NT SAIC 1991a). However, the proposed TSS is in a region where flooding occurs due to locally isolated intense convection storms. These storms create flash floods which normally last less than 6 hours.

**Surface Water Quality.** There are no NPDES permits for the site as there are no wastewater discharges to onsite or offsite surface waters. However, the state has issued sewage discharge permits for

sewage lagoons and ponds for NTS facilities. Because there are no surface waters at or near the proposed TSS, and because there will be no withdrawal or discharge to natural surface waters at NTS, the assessment of surface water quality is not applicable.

**Surface Water Rights and Permits.** Surface water rights are not an issue because NTS facilities do not withdraw surface water for use, nor do they discharge effluents directly to natural surface waters.

**Groundwater.** NTS is located within three groundwater subbasins of the Death Valley Groundwater Basin (NT USGS 1975a). Groundwater beneath the eastern portion of NTS is located in the Ash Meadows Subbasin; the western portion is located in the Alkali Flat Furnace Creek Ranch Subbasin; and a small part of the northwestern corner is located in the Oasis Valley Subbasin (figure 4.3.2.4–1). The proposed TSS is situated above the Ash Meadows Subbasin. Three primary aquifers are present within the Ash Meadows Subbasin: the Lower Carbonate (the deepest), the Volcanic, and the Valley-Fill (the shallowest) (NT DOE 1992d). Other aquifers are present to a limited extent under the area, but their water-bearing potential has not been thoroughly investigated. Limited aquifers may occur in other volcanic units, including lava flows and bedded tuffs.

The Lower Carbonate is the regional aquifer and is comprised of carbonate rocks of Middle Cambrian through Devonian age. The saturated thickness ranges from a few hundred to several thousand feet. This aquifer drains in a south-southwest direction, under Yucca and Frenchman Flat, toward Ash Meadows (NT USGS 1975a). The Volcanic and Valley-Fill aquifers range in thickness from zero to about 2,000 feet and are confined to their respective drainage basin (i.e., Frenchman and Yucca Flats) (NT DOE 1992d).

Depth to groundwater at NTS ranges from 500 to 2,400 feet. It is approximately 1,600 feet at Yucca Flat, 820 feet at Frenchman Flat, and over 2,000 feet at Pahute Mesa. There are, however, areas of perched water that lie at considerably shallower depths. In a 1992 study conducted by Desert Research Institute, data indicate that the total annual recharge to the regional aquifer under the entire NTS is approximately 4.1 BGY. In the vicinity of the proposed TSS, annual recharge to the regional aquifer is estimated at 2.3 BGY (NT DOE 1992b).

Groundwater flow under much of NTS is interconnected with groundwater flowing between Ash Meadows and the Amargosa Desert (NT USGS 1975a). Estimates vary as to how much groundwater flow reaches Ash Meadows from the subbasins of NTS, but it may be as much as 30 percent.

Devil's Hole is a water-filled cavern located approximately 30 miles southwest of the NTS at Ash Meadows Springs, and is known to contain the endangered pupfish (*Cyprinodon*). Studies have concluded that there was little possibility for pumping to cause observed declines at Devil's Hole (NT DOE 1993b:4-27).

**Groundwater Quality.** Currently, aquifers beneath NTS have not been classified by EPA. However, during an independent study (NT DOE 1989a) the aquifers beneath NTS were classified as Class IIa and Class IIb (groundwater currently used for drinking water). In 1972, the Nevada Operations Office instituted a Long Term Hydrological Monitoring Program to be operated by the EPA under an Interagency Agreement. Groundwater is monitored on and around NTS, at seven sites in other states, and at two off-NTS sites in Nevada. Only wells drilled previously for water supply or exploratory purposes are being used in the existing monitoring program. In compliance with the *Safe Drinking Water Act* and a State of Nevada drinking water supply system permit, drinking water wells and industrial use distribution systems are sampled and analyzed on a monthly basis. Groundwater samples collected are analyzed for a standard suite of parameters and constituents, including radioactive materials, nonradioactive materials, and other field parameters (pH and total dissolved solids).

Groundwater under portions of NTS has been affected as a result of nuclear testing activities conducted during the last 43 years. Additionally, several tests, comprising approximately 20 percent of the total, have been conducted below the water table or have been close enough that effects have extended below it. Table 4.3.2.4–1 shows the groundwater quality in the vicinity of the proposed TSS.

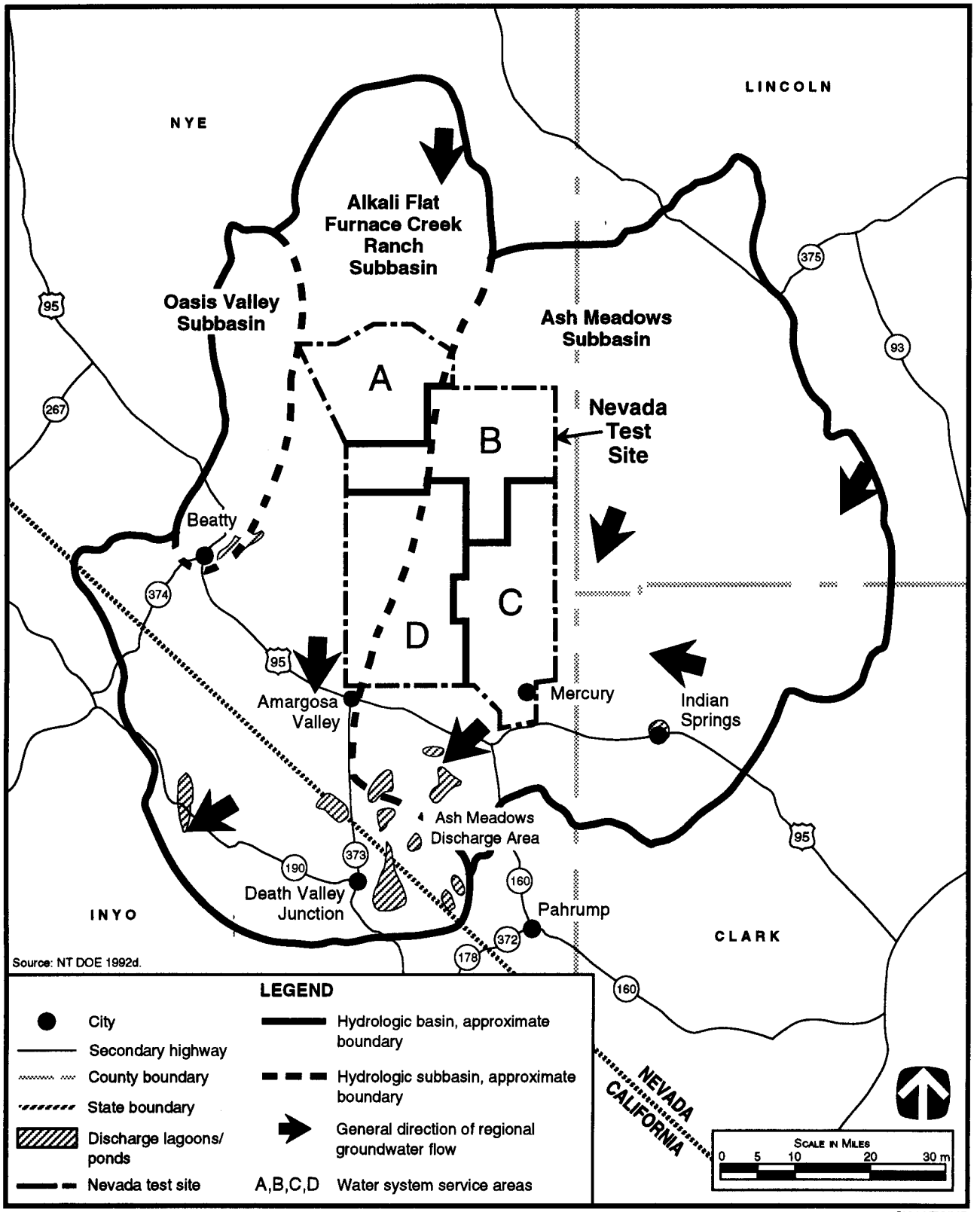



**FIGURE 4.3.2.4–1.**—*Groundwater Hydrologic Units at Nevada Test Site and Vicinity.*

Due to the past nuclear testing activities at NTS, radionuclide monitoring has been an important component of the groundwater monitoring program at the site. Because the water table lies at considerable depth, most radionuclides are absorbed before they can reach the groundwater. In general, tritium is the only radionuclide that appears in sampled water. Recent samples show tritium concentrations in the vicinity of the proposed TSS to be 32 pCi/l and decreasing. Subsurface migration of tritium to offsite areas is possible, but the probability of tritium reaching offsite wells or springs is minimal. It is also thought that the Lower and Upper Carbonate aquifers would most likely be the aquifers in which tritium might migrate to offsite areas (LLNL 1976a).

**Groundwater Availability, Use, and Rights.** Groundwater is the only local source of industrial and drinking water supply in the NTS area. Numerous production wells are located on NTS and distributed among various areas of the site. Figure 4.3.2.4–1 shows how the NTS water system has been divided into four water service areas (A, B, C, and D) based on the location of the water supply system and support facilities. Water usage on NTS is largely for potable, construction, and dust control purposes. Water supply wells at NTS draw water from the Lower and Upper Carbonate, the Volcanic, and the Valley-Fill aquifers. The total water usage in 1990 was 633 MGY, of which 335 MGY were withdrawn from the Ash Meadows Subbasin and 298 MGY were withdrawn from the Alkali Flat Furnace Creek Ranch Subbasin (figure 4.3.2.4–1). The pumping capacity for all the water supply wells at NTS is estimated at 3.9 BGY (NTS 1993a:6).

The State of Nevada strictly controls all ground and surface water withdrawals. The Appropriation Doctrine governs the acquisition and use of water rights. Groundwater for other than domestic use must be approved by the State Engineer. Wells drilled in designated groundwater basins require a

**TABLE 4.3.2.4–1.—*Groundwater Quality Monitoring at Nevada Test Site*[a]**

| Parameter | Unit of Measure | Water Quality Criteria and Standards[b] | Existing Conditions (1991, 1992) Well No.4[c] | Well No.4a[d] | Well No.C-1[e] |
|---|---|---|---|---|---|
| Alkalinity | mg/l | NA | 126 | 138 | 478 |
| Alpha (gross) | pCi/l | 15[f] | 4 | [g] | 6 |
| Arsenic | mg/l | 0.05[f] | 0.007 | 0.004 | 0.006 |
| Barium | mg/l | 2.0[f] | 0.00 | 0.01 | 0.11 |
| Beta (gross) | pCi/l | 50[h] | 6 | [g] | 11 |
| Chromium | mg/l | 0.1[f] | < 0.005 | < 0.005 | < 0.005 |
| Copper | mg/l | 1.3 | 0.00 | 0.00 | 0.00 |
| Lead | mg/l | 0.015[f] | < 0.005 | < 0.005 | < 0.005 |
| Nitrate | mg/l | 10[f] | 18.2 | 14.3 | 0.3 |
| pH | pH units | 6.5-8.5[i] | 8.13 | 8.22 | 7.63 |
| Sodium | mg/l | NA | 50 | 55 | 125 |
| Total dissolved solids | mg/l | 500[i] | 283 | 283 | 640 |
| Tritium | pCi/l | 20,000[f] | [g] | [g] | 32 |

[a] All data come from wells located downgradient of the proposed TSS.
[b] For comparison only.
[c] Data collected by Reeco on 07/22/91.
[d] Data collected by NVHD on 04/30/92.
[e] Data collected by Reeco on 08/01/91.
[f] National Primary Drinking Water Regulations (40 CFR 141).
[g] Does not analyze for paramater.
[h] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[i] National Secondary Drinking Water Regulations (40 CFR 143).
Note: NA - not applicable.
Source: NT DOE 1992e.

permit. The State Engineer may designate a groundwater basin when the indications are that groundwater withdrawal has or is likely to exceed basin recharge to the point of significantly affecting existing well users. Depending upon the groundwater situation, the State Engineer may deny all further groundwater withdrawal applications, allow selected types of uses, or issue temporary permits. Nevada water law allows for the "reasonable lowering" of groundwater levels. The determination of what is reasonable is made by the State Engineer on a case-by-case basis.

#### 4.3.2.5 *Geology and Soils*

**Geology.** NTS is located in the southern part of the Great Basin section of the Basin and Range Province in an intermediate position between the high, topographically closed basins in central Nevada and the low, connected basins of the Amargosa Desert-Death Valley region to the southwest. NTS consists of three flats (Yucca, Jackass, and Frenchman) surrounded by mountains (NT DOE 1988a).

The general region has been tectonically active in the near past and has numerous faults. NTS lies in an area of moderate historic seismicity on the southern margin of the Southern Nevada East-West Seismic Belt in Seismic Zones 2B and 3, indicating that moderate to major damage could occur as a result of earthquakes (figure 4.3.2.5–1). Since about the year 1848, more than 4,000 earthquakes have been recorded within a 150-mile radius of NTS. Most of these were minor events with Richter magnitudes of less than 5.5. The largest event on record, which took place 100 miles west in Owens Valley, CA, had an estimated magnitude of 8.3. In 1992, an earthquake of magnitude 5.6 occurred in the southwest corner of the site under Little Skull Mountain. The maximum acceleration from this earthquake was approximately 0.21g at Amargosa Valley.

The Yucca and Carpetbag faults were active during the late Quarternary and both are considered to be capable faults within the definition of 10 CFR 100, Appendix A. The Yucca fault has undergone surface rupture within the past few thousand to tens of thousands of years. Some earthquakes can be directly associated with the fault trace and also beyond the south end of the mapped section in the Yucca Pass, suggesting that the fault may continue in that direction. No significant vertical surface displacement has occurred on the Carpetbag fault system during the past 150,000 years, but there is evidence of episodes of fracturing and possible minor faulting from 30,000 to 240,000 years ago with average recurrence interval at about 25,000 years, for the last 125,000 years. The Carpetbag fault has been mapped in the subsurface beyond the southern end of Yucca Basin and may project to the northeast of the proposed TSS. Possible magnitude, intensity, and acceleration of earthquakes along the Yucca and Carpetbag faults have not been estimated.

The Cane Spring fault, which lies approximately 5 miles southeast of the proposed TSS, does not show Holocene displacement but is thought to have been the source of a magnitude 4.3 earthquake in 1971. The maximum credible earthquake associated with the Cane Spring fault is expected to produce a peak acceleration of 0.67g with a 6.7 magnitude (NT LANL 1983a). The recurrence interval is estimated at 10,000 to 30,000 years.

The most recent volcanic activity in the immediate area was 3.7 million years ago, and the likelihood for renewed activity in the next 10,000 years is slight (NT LANL 1983a). NTS lies approximately 150 miles southeast of the Long Valley area of California, an area of potential volcanic eruption of the Mount St. Helens type.

**Soils.** Limited soil studies have been performed at NTS. Studies in adjacent areas have divided soils into three major types: shallow soils developed in the uplands and mountains; soils on valley fill and nearly level to moderately sloping outwash plains, alluvial fans, and fan aprons; and playas and soils on nearly level flats and basins. Possible erosion hazards range from slight to severe while the shrink-swell potential ranges from low to high for these soils. The potential for wind erosion and shrink-swell increases into the playas and basins. The potential for water erosion increases with increasing slope. The soils at NTS are considered acceptable for standard construction techniques.

#### 4.3.2.6 *Biotic Resources*

The following describes biotic resources at NTS including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.

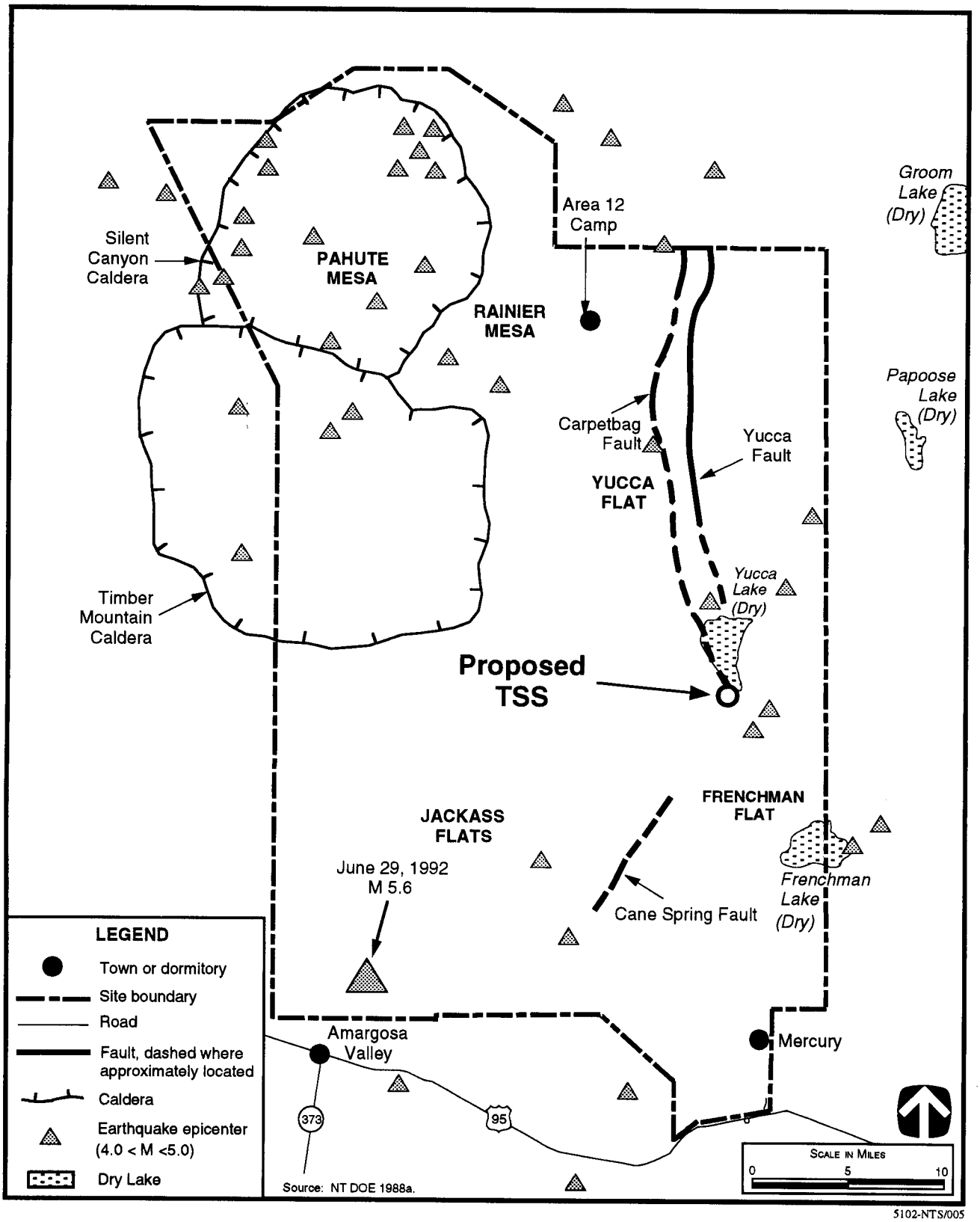



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**FIGURE 4.3.2.5–1.**—***Major Fault Systems, and Historic Earthquakes in Nevada Test Site Region.***

Within each biotic resource area the discussion focuses first on NTS as a whole and then on the proposed TSS. Scientific names of species identified in the text are presented in appendix C Also presented in appendix C is a list of threatened and endangered species that may be found on the site or in the vicinity of NTS.

**Terrestrial Resources.** NTS lies in a transition area between the Mojave and Great Basin deserts. As a result, flora and fauna characteristic of both deserts are found within the site boundaries (NT ERDA 1976a). Approximately 8 square miles of NTS have been developed, which represent less than 1 percent of the site; thus, natural plant communities are found across most of NTS (NT DOE 1989b). The site has been divided into nine major communities as shown in figure 4.3.2.6–1 (NT ERDA 1976a).

Of the communities present onsite, the mountains, hills and mesas, sagebrush, creosote bush, and hopsage-desert thorn communities are the most extensive. Saltbush and desert thorn communities occupy more limited areas adjacent to the playas in Frenchman and Yucca Flats (NT ERDA 1976a). Introduced plants such as red brome, cheatgrass, and Russian thistle have become important species in some areas. These plants rapidly invade disturbed areas and delay revegetation of areas by native species (NT ERDA 1976a; NT Hunter 1991a). A total of 711 taxa of vascular plants have been identified on or near NTS (NT ERDA 1976a).

Terrestrial wildlife found on NTS includes 33 species of reptiles, 220 species of birds, and 49 species of mammals (NT Greger 1992a; NTS 1990a:1; NTS 1990a:2). Species common to NTS include the side-blotched lizard, western shovel-nosed snake, blackthroated sparrow, red-tailed hawk, Merriam's kangaroo rat, and Great Basin pocket mouse. Water holes, both natural and man-made, are important to many species of wildlife, including game animals such as pronghorn and mule deer (NTS 1990a:1; NTS 1990a:2). Hunting is not permitted anywhere on NTS. Raptors and carnivores are two ecologically important groups on NTS and are represented by species such as the turkey vulture and rough-legged hawk, and long-tailed weasel and bobcat, respectively (NT ERDA 1976a). A variety of migratory birds has been found at NTS. Migratory birds, their nests and eggs are protected by the *Migratory Bird Treaty Act.* Eagles are similarly protected by the *Bald and Golden Eagle Protection Act.*

Vegetation cover in the proposed TSS falls primarily within the creosote bush community (figure 4.3.2.6–1). Fauna found in the proposed TSS is expected to be closely associated with Mojave desert fauna and species could include the banded gecko, desert iguana, Gambel's quail, roadrunner, round-tailed ground squirrel, and coyote (NT ERDA 1976a).

**Wetlands.** National Wetland Inventory maps of NTS have not been prepared, nor have wetlands been delineated on the site. However, small wetland areas (less than 1 acre) may be associated with site springs (NTS 1992a:5). There are no known wetlands in the proposed TSS.

**Aquatic Resources.** Potential aquatic habitat on NTS includes surface drainages, playas, springs, and man-made reservoirs. There are no continuously flowing streams on the site and permanent surface water sources are limited to a few small springs. These surface drainages, playas, and springs are unable to support permanent fish populations (NT ERDA 1976a; NT Greger nda). Man-made construction water reservoirs located throughout the site support three introduced species of fish: bluegill, goldfish, and golden shiners (NTS 1992a:6). There are no known aquatic resources in the proposed TSS.

**Threatened and Endangered Species.** Twenty-four Federal- and state-listed threatened, endangered, and other special status species have been identified in the vicinity of NTS (appendix table C–3). Seventeen have been observed on NTS (table 4.3.2.6–1). The remaining species, listed in appendix C, are transient species which may occur during migration. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on NTS.

The peregrine falcon has been recorded on NTS, but the threatened desert tortoise is the only resident species known to inhabit NTS that is protected under the *Endangered Species Act.* The range of the desert tortoise lies in the southern third of NTS. Tortoises on NTS are most commonly found in the areas shown

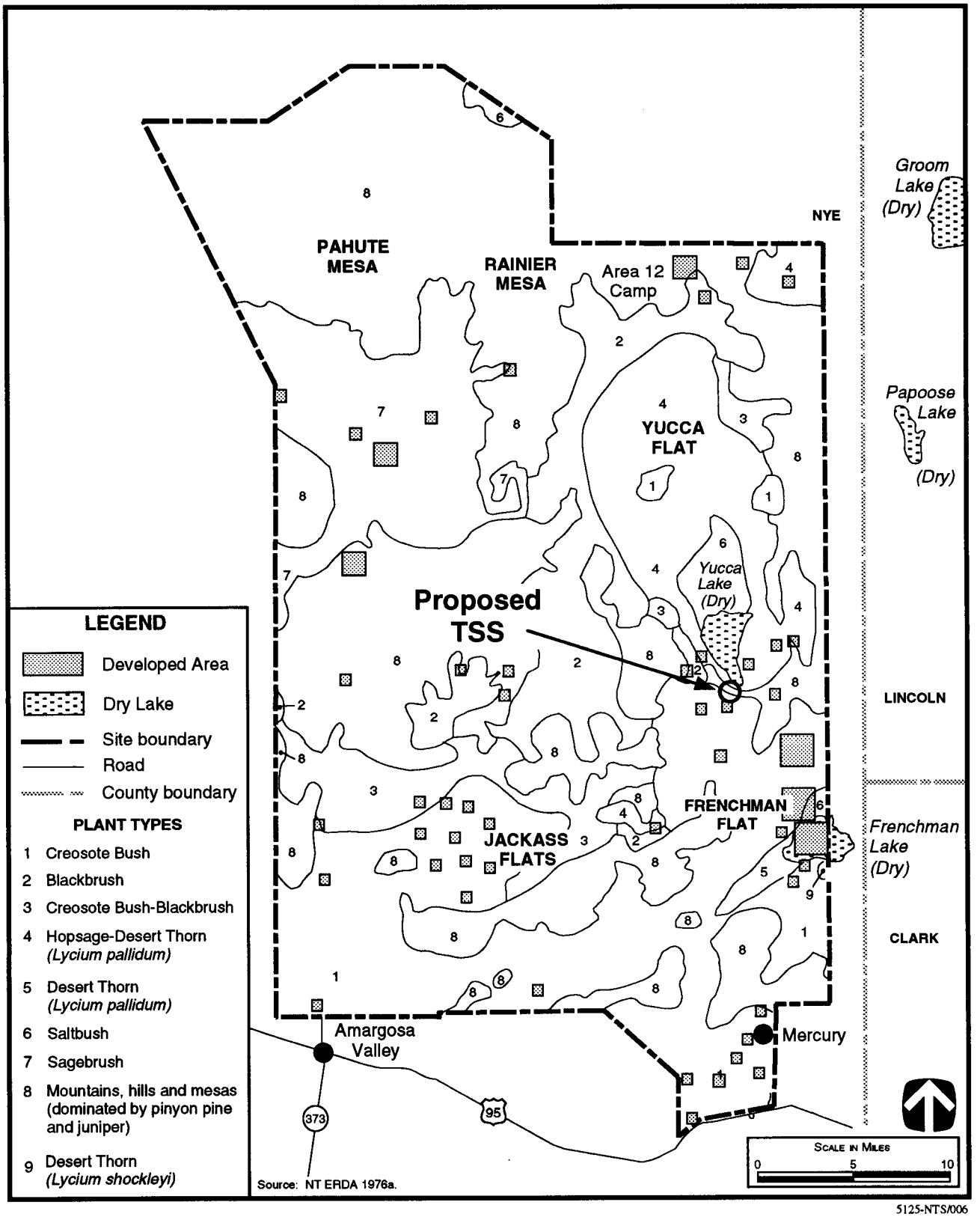


**FIGURE 4.3.2.6–1.—*Distribution of Plant Communities at Nevada Test Site.***

**TABLE 4.3.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of the Proposed Tritium Supply Site at Nevada Test Site***

| Species | Status[a] Federal | Status[a] State | Known or Potential Habitat/Location |
|---|---|---|---|
| **Birds** | | | |
| Ferruginous hawk | C2 | NL | Woodland/grassland |
| Loggerhead shrike | C2 | NL | Most habitats |
| Mountain plover | C2 | NL | Semi-arid plains, grasslands, plateaus |
| Peregrine falcon[b] | E | E | Open country, cliffs |
| Western snowy plover | C2 | NL | Sand flats |
| White-faced ibis | C2 | NL | Migrant visitor to ponds |
| **Reptiles** | | | |
| Desert tortoise[c] | T | T | Mojave desert biome |
| **Fish** | | | |
| Devils Hole pupfish[b, d] | E | E | Deep limestone pool, Devil's Hole |
| **Plants** | | | |
| Beardtongue | C2 | NL | Open area, loose soil |
| Beatley milkvetch | C1 | CE | Shallow gravelly soil in open flat volcanic bedrock |
| Beatley phacelia | C2 | NL | Gravel/volcanic tuff, canyon washes, steep barren slopes |
| Black wooly-pod | C2 | NL | Unstable, steep gravelly slopes of volcanic tuff |
| Camissonia megalantha | C2 | NL | Shad scale, disturbed soil |
| Green-gentian | C2 | NL | Gravelly slopes and valley bottoms |
| Kingston bedstraw | C2 | NL | Ravines, gulleys |
| Mojave fishhook cactus | NL | CY | Yucca Mountain area |
| White bear desert-poppy | C2 | NL | Shallow gravelly soil, limestone outcrop |

[a] Status code: C1 - candidate, Category 1 (appropriate to list); C2 - candidate, Category (possibly appropriate to list); CE - critically endangered by authority of NRS 527.270 (State Division of Forestry); CY - protected by authority of NRS 522.60-.120 (Nevada Cacti and Yucca Law); E - endangered; NL - not listed; T - threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur in proposed TSS.

[d] Only known location of this species is outside NTS 24 miles southwest of Mercury.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; NT DOE 1991b; NT DOE 1991c; NT FWS 1989a; NT FWS 1991a; NT Greger 1992a; NT SAIC 1991a; NTS 1990a:1: NTS 1990a:2.

on figure 4.3.2.6–2. Further surveys may reveal other areas of concentration. The abundance of tortoises on NTS is considered low to very low relative to other areas within this species' geographic range. The proposed TSS is located near one of the areas having the highest relative number of desert tortoise on NTS. Both tortoise remains and scat have been observed in the proposed site area (NT EG&G 1991a). Densities of tortoises range from 0 to 45 individuals per square mile, with most habitats probably having densities of 0 to 20 individuals per square mile (NT DOE 1991b).

The only known population of the Devils Hole pupfish lives in a single, spring-fed sinkhole pool in Ash Meadows, approximately 34 miles southwest of the proposed TSS. There is concern over the survival of the pupfish and other sensitive species found in the Ash Meadows area due to the threat of declining water levels (NT DOI 1991a; NT ERDA 1977a; NT SAIC 1991a). Twenty-nine sensitive plant species have also been identified on NTS. Eight of these species are Federal candidates for listing (table 4.3.2.6–1). Five Federal candidate animal species have been recorded on NTS. The loggerhead shrike is a permanent resident that breeds

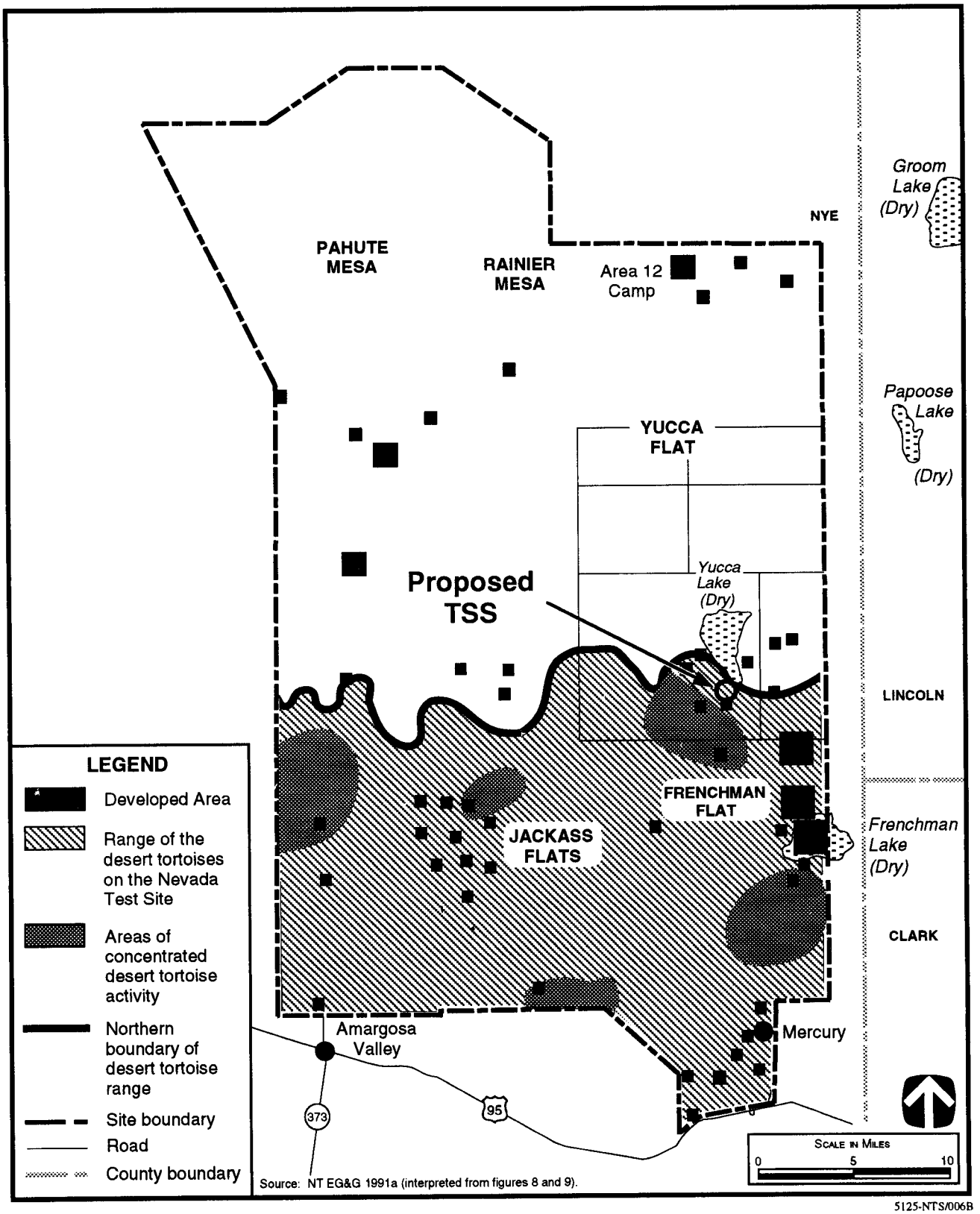


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**FIGURE 4.3.2.6–2.—*Distribution of Desert Tortoise at Nevada Test Site.***

on NTS. The ferruginous hawk is a winter resident species observed onsite in recent years. The white-faced ibis, mountain plover, and western snowy plover have also been observed onsite. Occurrence of these species in the proposed TSS is unknown.

#### 4.3.2.7 *Cultural and Paleontological Resources*

**Prehistoric Resources.** Prehistoric site types identified on NTS include habitation sites with wood and brush structures, windbreaks, rock rings, or cleared areas; rockshelters; petroglyphs (rock art); hunting blinds; rock alignments; quarries; temporary camps; milling stations; roasting ovens or pits; water caches; and limited activity locations. Approximately 4 percent of NTS has been inventoried for cultural resources. This includes all lands managed through a Memorandum of Agreement with Nellis Air Force Base. Excluding sites in the Yucca Mountain project area, 916 prehistoric sites and 34 prehistoric/historic sites have been recorded and recommended as eligible for inclusion in the NRHP. The Nevada SHPO has concurred that 82 prehistoric sites and 1 prehistoric/historic site are eligible.

Cultural resources surveys and site evaluations have been conducted in the vicinity of the proposed TSS. Numerous prehistoric sites have been recorded including lithic scatters, temporary camps, and milling stations. Milling stations are especially prevalent in proximity to the Yucca Lake playa margins. Several prehistoric rockshelters have been identified on Hogback Ridge. Additional prehistoric sites may occur in unsurveyed portions of the TSS. These sites have not been evaluated for NRHP eligibility.

**Historic Resources.** Historic site types on NTS include mines and prospects, trash dumps, settlements, campsites, ranches, homesteads, spring developments, trails, and roads. Excluding the Yucca Mountain project area, 32 historic sites have been recorded and recommended as eligible for the NRHP. The Nevada SHPO concurred that two historic sites are eligible. The only site currently listed on the NRHP is the Emigrant Trail used by the "49ers" which traverses the southwestern corner of NTS.

In the vicinity of the TSS, some historic sites have been recorded including refuse scatters. Additional historic sites may occur in unsurveyed portions of the TSS. These sites have not been evaluated for NRHP eligibility.

**Native American Resources.** At the time of Euro-American contact, southern Nevada was inhabited by the Western Shoshone and Southern Pahute. Families foraged in small groups from the spring through the fall. During winter, relatively stable villages of several families were established in relatively warm places, close to caches of pine nuts, seeds, and dried meats.

Native American resources include burials, ceremonial sites, musical stones, medicine rocks, petroglyphs, and traditional use areas. Local plants important in ritual and ceremonial activities include jimsonweed, juniper, greasewood, creosote, Indian tobacco, piñon pine, buckbush, and scrub oak. Concern has been expressed about the availability and accessibility of such resources.

Consultation with Native American cultural and religious leaders has been conducted for other projects at or near NTS to identify traditional cultural resources that may be affected by Federal actions, and to obtain Native American recommendations for mitigating potential adverse impacts on traditional cultural resources. DOE has established ongoing consultation with 13 Native American tribes and one pan-tribal organization (the Owens Valley Board of Trustees) with cultural ties to NTS.

**Paleontological Resources.** The surface geology of NTS is characterized by alluvium-filled valleys surrounded by ranges composed of Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas. The Pre-Cambrian and Paleozoic rocks at NTS represent relict deposits made in shallow water at the submerged edge of a continental platform which ran from Mexico to Alaska and existed throughout most of the Paleozoic. Although the Pre-Cambrian sedimentary deposits contain no fossils or only a few poorly-preserved fossils, the Paleozoic marine limestones are moderately to abundantly fossiliferous. Marine fossils found in the same Paleozoic formations on Nellis Air Force Range, adjacent to NTS to the north, include trilobites, conodonts, ostracods, solitary and colonial corals, brachiopods, algae, gastropods, and archaic fish.

These fossils, however, are relatively common and have low research potential.

Tertiary volcanic deposits are not expected to contain fossils; however, the late Pleistocene terrestrial vertebrate fossils of the Rancholabrean Land Mammal Age could be expected in the Quaternary deposits. The possibility of finding mammoth, horse, camel, and bison remains might be expected because such fossils have been found at Tule Springs, 35 miles from the southern edge of NTS and in Nye Canyon. Fossils found at Tule Springs include bison, deer, a small donkey-like horse, camel, Columbia mammoth, ground sloth, giant jaguar, bobcat, coyote, muskrat, and a variety of rabbits, rodents, and birds. This paleontological assemblage has high research potential. Although Quaternary deposits with paleontological materials may occur on NTS, no known fossil localities have been recorded to date.

Other Pleistocene resources include pack rat middens, which are studied by scientists at the University of Nevada, Reno, the Desert Research Institute, and New Mexico Tech, to investigate paleoclimatic regimes. Pack rat middens would not be expected to be found at the proposed TSS, which is located on an alluvial fan.

#### 4.3.2.8 *Socioeconomics*

Socioeconomic characteristics addressed at NTS include employment and local economy, population, housing, public finance, and local transportation. Statistics for employment and local economy are based on the economic study area that encompasses 4 counties around NTS. The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for the remaining socioeconomic characteristics are based on the ROI, a 2-county area in which 97 percent of all NTS employees reside: Clark County (82 percent) and Nye County (15 percent). (See figure 4.3–1 for a map of counties and cities.) Fiscal characteristics of the jurisdictions in the ROI are presented in the public finance section in appendix tables D.3–31 and D.3–32. The school districts most likely to be affected by the proposed action include those in Clark County and Nye County. Assumptions, assessment methodologies, and supporting data are presented in appendix D.

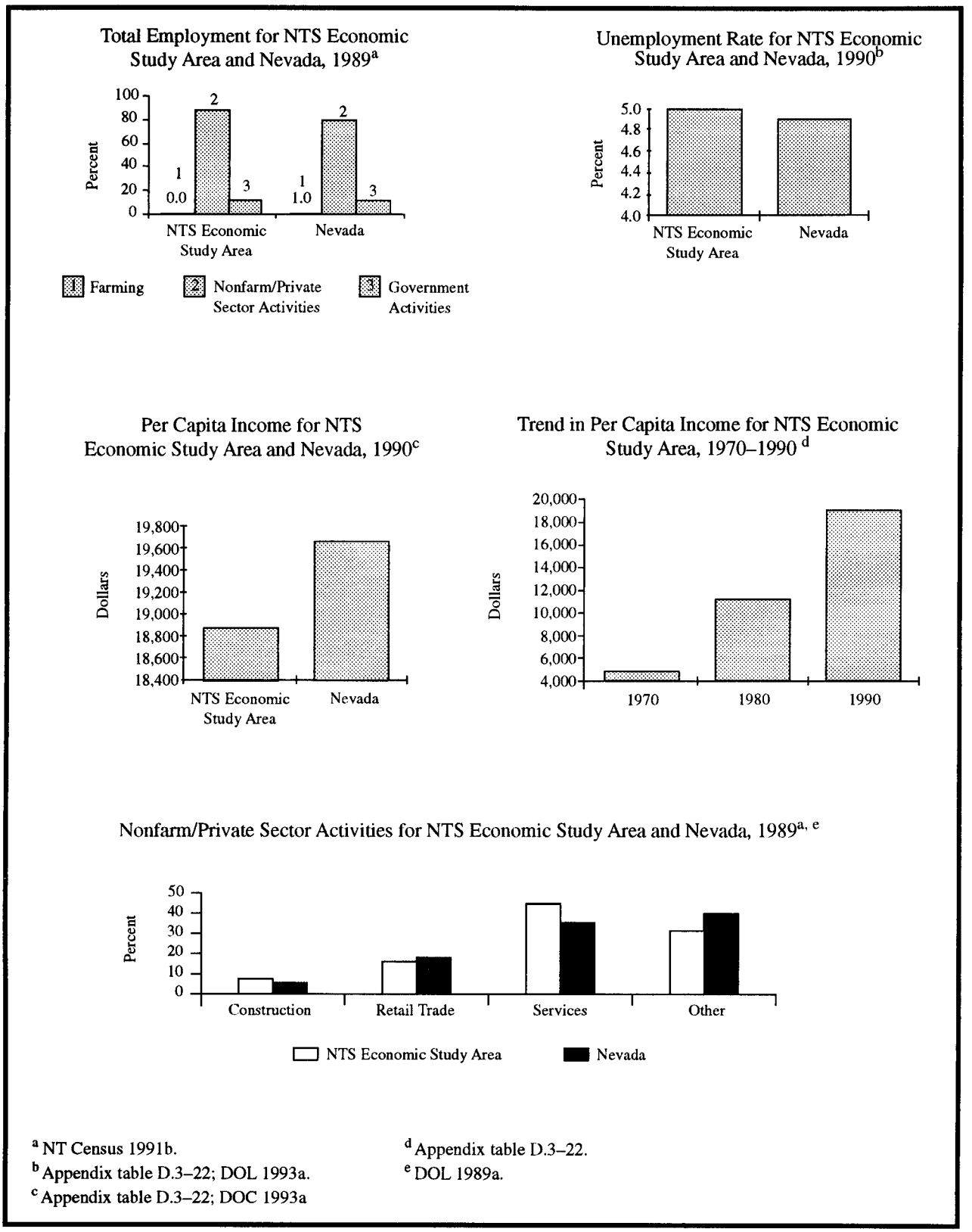
**Employment and Local Economy.** Employment and local economy statistics for the NTS economic study area are presented in appendix table D.3–22, and summarized in figure 4.3.2.8–1. Between 1970 and 1990, the civilian labor force in the economic study area increased 220 percent. The unemployment rate in the economic study area in 1990 was approximately the same as the state rate. The 1990 per capita income in the economic study area was also approximately the same as the State of Nevada.

As shown in figure 4.3.2.8–1, the percentage of total employment involving farming, governmental activities, and nonfarm private sector activities of manufacturing, retail trade, and services was similar in the economic study area and the state.

In 1990, NTS employed 8,019 persons (2.1 percent of the total economic study area employment), increasing from 6,840 persons in 1970. Historical and future employment at NTS and the distribution of NTS employees by place of residence in the ROI are presented in appendix tables D.2.1–1 and D.3–21, respectively.

**Population and Housing.** Population and housing distribution in the ROI is presented in appendix tables D.3–25 and D.3–28, and summarized in figure 4.3.2.8–2. The percent increase in population in the ROI from 1970 to 1990 was 26 percent greater than that of the state except for the city of Henderson which experienced a 300-percent increase. The percent increase in housing units between 1970 and 1990 was approximately 50 percent greater than the percent increase for the state, with the exception of the city of Henderson (400-percent increase). Homeowner and rental vacancy rates in the ROI in 1990 were similar to those experienced by the state.

**Public Finance.** Financial characteristics of the local jurisdictions in the ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are




[a] NT Census 1991b.
[b] Appendix table D.3–22; DOL 1993a.
[c] Appendix table D.3–22; DOC 1993a
[d] Appendix table D.3–22.
[e] DOL 1989a.

**FIGURE 4.3.2.8–1.—*Economy for Nevada Test Site Economic Study Area.***

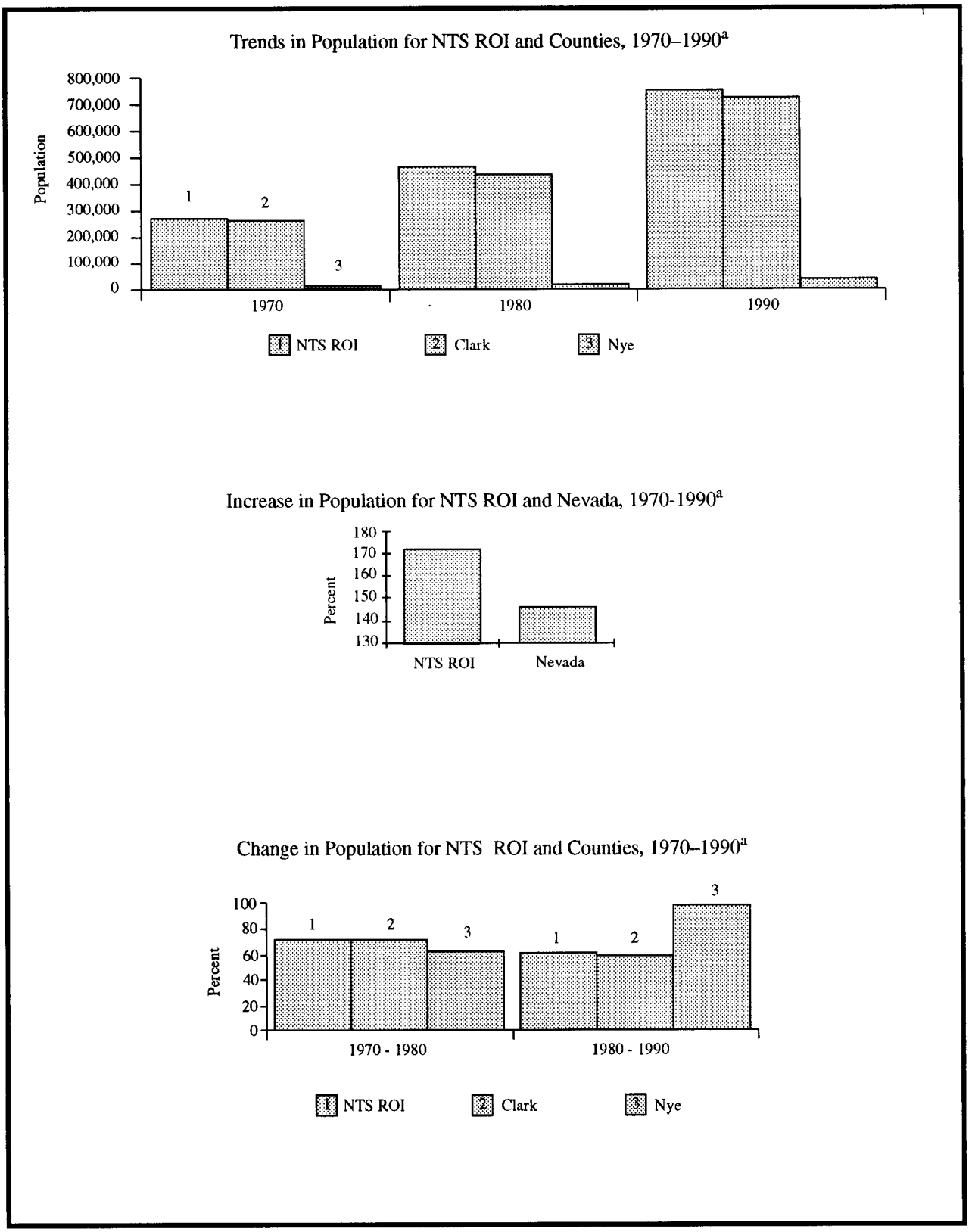
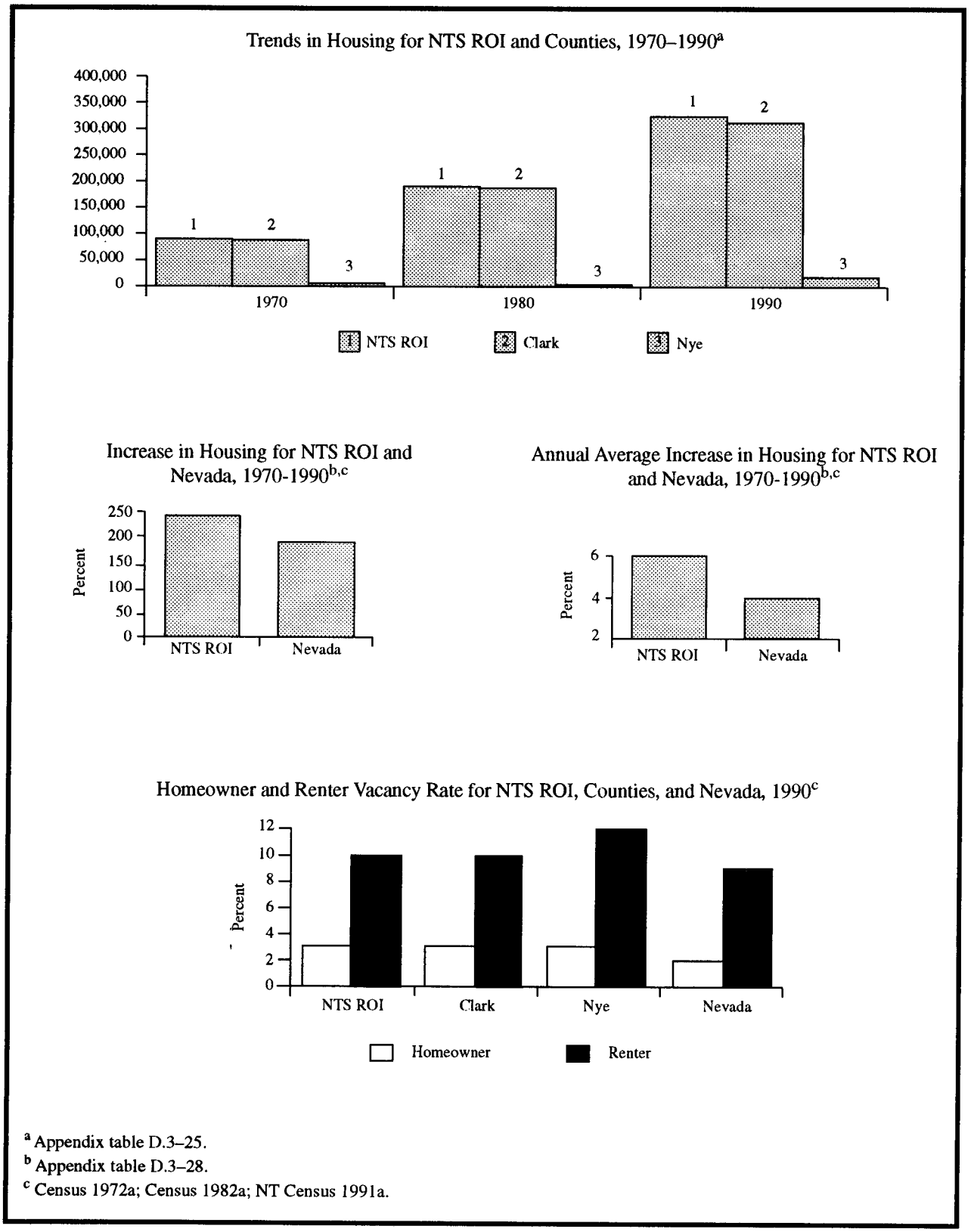



**FIGURE 4.3.2.8–2.—*Population and Housing for Nevada Test Site Region-of-Influence* [Page 1 of 2].**




[a] Appendix table D.3–25.
[b] Appendix table D.3–28.
[c] Census 1972a; Census 1982a; NT Census 1991a.

**FIGURE 4.3.2.8–2.—*Population and Housing for Nevada Test Site Region-of-Influence* [Page 2 of 2].**

presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.3–31 and D.3–32, and figure 4.3.2.8–3 summarizes local government's revenues less its expenditures.

**Local Transportation.** Vehicular access to NTS is provided by U.S. Route 95 (divided highway) to the south with off-road access to the northeast provided via State Route 373 (figure 4.3–1). Road segments providing access to NTS traffic experience little traffic congestion outside of the Las Vegas metropolitan area. Traffic on U.S. Route 95 generally experiences greater congestion than traffic on State Route 373. Minor congestion may occur due to accidents and maintenance activities. No major improvements are scheduled for those segments providing immediate access to NTS (figure 4.3.1–1) (NT DOT 1992a).

Although there is no public transportation system serving NTS, a contract bus service for workers is available at a nominal cost. The major railroad in the ROI is the Union Pacific Railroad located approximately 50 miles east of NTS near the city of Las Vegas. A 9-mile, standard gauge railroad serves Area 25 of NTS but does not connect with the Union Pacific Railroad (NT ERDA 1977a). There are no navigable waterways within the ROI.

McCarran International Airport in the city of Las Vegas provides jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located throughout the ROI (DOT 1991a).

### 4.3.2.9 *Radiation and Hazardous Chemical Environment*

The following provides a description of the radiation and hazardous chemical environment at NTS. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

**Radiation Environment.** Major sources of background radiation exposure to individuals in the vicinity of NTS are shown in table 4.3.2.9–1. All annual doses to individuals from background radiation are expected to remain constant over time.

**TABLE 4.3.2.9–1.—*Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Nevada Test Site Operations***

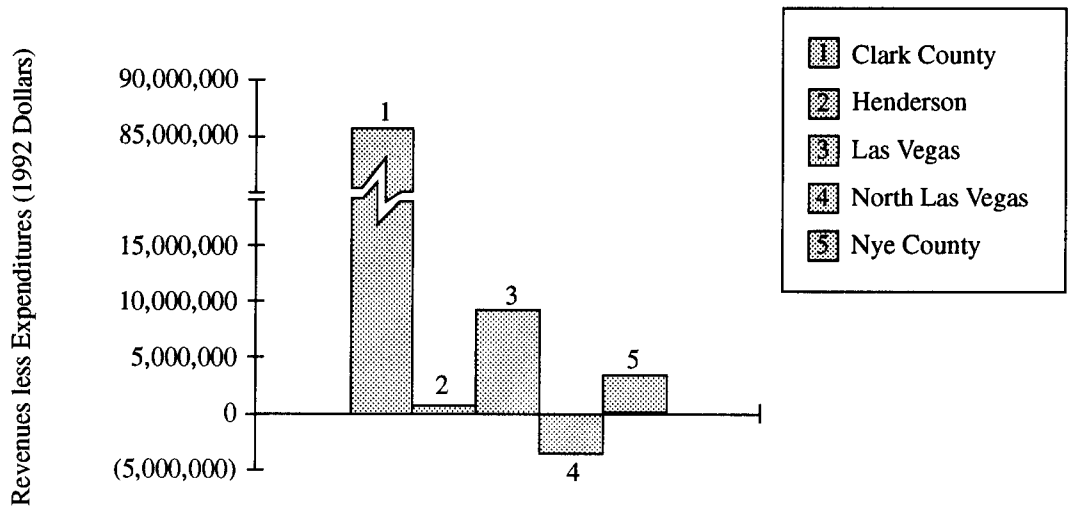
| Source | Committed Effective Dose Equivalent (mrem/yr) |
|---|---|
| **Natural Background Radiation**[a] | |
| Cosmic and external terrestrial radiation[b] | 78 |
| Internal terrestrial radiation | 39 |
| Radon in homes (inhaled) | 200 |
| **Other Background Radiation**[b] | |
| Diagnostic X-rays and nuclear medicine | 53 |
| Weapons test fallout | <1 |
| Air travel | 1 |
| Consumer and industrial products | 10 |
| **Total** | 382 |

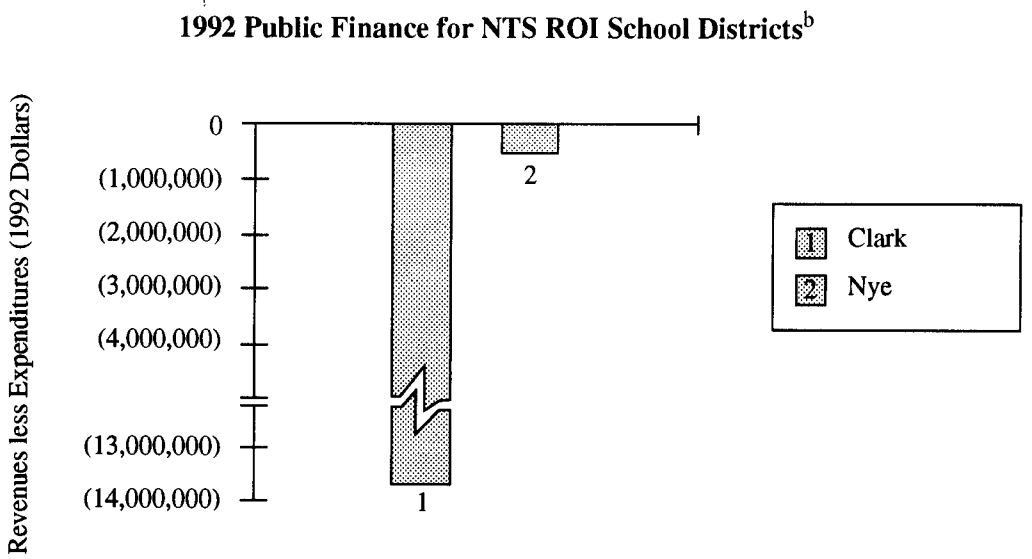
[a] From NT DOE 1993e.Value for radon is an average for the United States.
[b] From NCRP 1987a.

Accordingly, the incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to NTS operations.

Releases of radionuclides to the environment from NTS operations provide another source of radiation exposure to individuals in the vicinity of NTS. The radionuclides and quantities released from NTS operations in 1992 are listed in the *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report-1992* (DOE/NV/10630-66). The doses to the public resulting from these releases are presented in tables 4.3.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1992 report were used in the development of the reference environment (No Action) radiological releases at NTS in the year 2010 (section 4.3.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (appendix section E.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from NTS operations in 1992 is estimated to




[a] NT City 1992a; NT County 1992a.
[b] NT School 1992a.

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**FIGURE 4.3.2.8–3.—*1992 Local Government Public Finance for Nevada Test Site Region-of-Influence.***

**TABLE 4.3.2.9–2.—*Doses to the General Public from Normal Operation at Nevada Test Site, 1992 (committed effective dose equivalent)***

| Affected Environment[a] | Atmospheric Releases | | Liquid Releases | | Total | |
|---|---|---|---|---|---|---|
| | Standard[b] | Actual | Standard[a] | Actual | Standard[a] | Actual |
| Maximally exposed individual (mrem) | 10 | 0.026 | 4 | 0.0 | 100 | 0.026 |
| Population within 50 miles[c] (person-rem) | None | 0.029 | None | 0.0 | 100 | 0.029 |
| Average individual within 50 miles[d] (mrem) | None | 0.0013 | None | 0.0 | None | 0.0013 |

[a] From NT DOE 1993e.

[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834. If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[c] In 1992, this population was approximately 21,750.

[d] Obtained by dividing the population dose by the number of people living within 50 miles of the site.

be approximately $1.3 \times 10^{-8}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of NTS operations is about 13 chances in 1 billion. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Approximately $1.5 \times 10^{-5}$ excess fatal cancers were estimated from normal operations in 1992 to the population living within 50 miles of NTS. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a). Based on this national rate, the number of fatal cancers from all causes expected during 1992 in the population living within 50 miles of NTS was 43.5. This number of expected fatal cancers is much higher than the estimated $1.5 \times 10^{-5}$ fatal cancers that could result from NTS operations in 1992.

Workers at NTS receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.3.2.9–3 includes the average, maximum, and total occupational doses to NTS workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (appendix section E.2), the number of excess fatal cancers to NTS workers from operations in 1992 is estimated to be 0.0008.

**TABLE 4.3.2.9–3.—*Doses to the Worker Onsite from Normal Operation at Nevada Test Site, 1992 (committed effective dose equivalent)***

| Affected Environment[a] | Onsite Releases and Direct Radiation | |
|---|---|---|
| | Standard[b] | Actual |
| Average worker (mrem) | None | 2.6 |
| Maximally exposed worker (mrem) | 5,000 | 750 |
| Total workers (person-rem) | None | 2 |

[a] From DOE 1993. The number of badged workers in 1992 was approximately 780.

[b] From 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report-1992* (DOE/NV/10630-66). The concentrations of radioactivity in various environmental media (e.g., air and water) and in animal tissue in the site region (onsite and offsite) are also presented in the same reference. NTS operations contribute negligible radioactivity to these media.

**Chemical Environment.** The background chemical environment important to human health consists of: the atmosphere, which may contain toxic chemicals that can be inhaled; drinking water, which may contain toxic chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.3.2.3 and 4.3.2.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at NTS via inhalation of air containing pollutants released to the atmosphere by NTS operations. Risks to public health from other possible pathways such as ingestion of contaminated drinking water or direct exposure are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous/toxic air pollutants and their applicable standards are presented in section 4.3.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix section E.3, with risk assessment specific for NTS presented in appendix tables E.3.4–9, E.3.4–11, E.3.4–12, and summary table E.3.4–14.

Health impacts to NTS workers during normal operation may include those from: inhalation of the workplace atmosphere, drinking NTS potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. NTS workers are also protected by adherence to occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 3790.1B) ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at NTS are expected to be substantially better than required by standards.

**Health Effects Studies.** The epidemiologic studies surrounding NTS have concentrated on health effects in soldiers and children associated with nuclear testing rather than operation emissions. Results are contradictory regarding the observed leukemia incidence and deaths in exposed children, with some studies reporting excess whereas others report no excess. There were questions raised about the analytical methods used in some of these studies. For soldiers, the results regarding leukemia and polycythemia vera were different between two studies relating to nuclear test explosions, but reanalyses showed leukemia, respiratory, and other cancers to be associated only with exposure to higher doses (e.g., more than 300 mrem for leukemia cases). For a more detailed description of the study findings reviewed, refer to appendix section E.4.3.

**Accident History.** Nuclear testing began at NTS in 1951. There were some 100 atmospheric nuclear explosions before the Limited Test Ban Treaty was implemented in 1953. Since then, all nuclear tests have been conducted underground (appendix section A.1.2).

Since 1970, there were 126 nuclear tests which resulted in a release to the atmosphere of

approximately 54,000 Ci of radioactivity. Of this amount, 11,500 Ci were accidental due to containment failure (massive releases or seeps) and late-time seeps (seeps are small releases after a test when gases diffuse through pore spaces of the overlying rock). The remaining 42,500 Ci were operational releases. From the perspective of human health risk, if the same person had been standing at the boundary of NTS in the area of maximum concentration of radioactivity for every test since 1970, that person's total exposure would be equivalent to 32 extra minutes of normal background exposure or the equivalent of one-thousandth of a single chest X-ray (OTA 1989a).

In the event of an accident, each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. Section 4.1.9 provides a description of DOE's emergency preparedness program.

The NTS Emergency Preparedness Plan is designed to minimize or mitigate the impact of any emergency upon the health and safety of employees and the public. The plan integrates all emergency planning into a single entity to minimize overlap and duplication, and to ensure proper responses to emergencies not covered by a plan or directive. The manager of the Nevada Operations Office has the responsibility to manage, counter, and recover from an emergency occurring at NTS.

The plan provides for identification and notification of personnel for any emergency that may develop during operational and nonoperational hours. The Nevada Operations Office receives warnings, weather advisories, and any other communications that provide advance warning of a possible emergency. The plan is based upon current Nevada Operations Office vulnerability assessments, resources, and capabilities regarding emergency preparedness.

#### 4.3.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for NTS. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.2. Table 4.3.2.10–1 presents a summary of waste management at NTS for 1991.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at NTS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

DOE has decided that underground testing areas should be governed pursuant to the provisions of CERCLA. Preliminary Assessment/Site Investigation reports and a Hazardous Ranking System package were provided to the EPA for their use in determining whether NTS should be included on the NPL. In May 1993, the State of Nevada issued a letter to DOE indicating it did not appear that EPA would make a decision on the NPL status of the NTS in the near future. EPA is also drafting a two-party agreement between the State of Nevada and DOE. The State of Nevada and DOE are negotiating a Federal Facility Compliance Agreement addressing environmental restoration and waste management on the NTS. An Agreement in Principle has been signed with the State of Nevada to provide oversight of environmental, safety and health activities, including environmental restoration. However, the Agreement in Principle is not a legally binding document and does not provide mandates or drivers to accomplish environmental restoration.

The DOE Nevada Operations Office completed a waste minimization plan for NTS in 1991 and created an organization with the mission to promote waste minimization and pollution prevention, and to ensure compliance with DOE requirements. NTS currently generates waste from ongoing operations and remediation associated with past activities, and receives

**TABLE 4.3.2.10–1.—*Current Waste Management at Nevada Test Site***

| Category | 1991 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Transuranic**[a] | None | None | None | Containers on asphalt pads | 10,850[b] | None–WIPP in the future | NA |
| **Mixed Transuranic**[a] | None | None | None | Included in TRU | Included in TRU | None–WIPP in the future | NA |
| **Low-level** | | | | | | | |
| Liquid | Included in solid | Evaporation/ solidification[c] | 29,700[d] (6,000,000 GPY) | Double-lined holding tanks | 5,500[d] (1,100,000 gal) | NA | None[e] |
| Solid | 12,914[f] | None | None | None | None | Shallow burial | 643,300 |
| **Mixed Low-level** | | | | | | | |
| Liquid | None | Evaporation/ solidification[g] and offsite incineration | 29,700[d] (6,000,000 GPY) | Double-lined holding tanks | 5,500[d] (1,100,000 gal) | NA | None |
| Solid | None | None | None | None | None | Pit | 155,530 |
| **Hazardous** | | | | | | | |
| Liquid | Included in solid | None | Planned | NA | None | NA | NA |
| Solid | 124[h] | None | None | 90-day pad | 388 | Contracted offsite | NA |
| **Nonhazardous (Sanitary)** | 10,200[i] | None | None | None | None | Landfill (onsite) | Expandable as required as of November 1994, 600,000 $yd^3$ available |
| **Nonhazardous (Other)** | 108,253 | None | None | None | None | Landfill (onsite) | Expandable as required |

[a] All TRU waste at NTS is considered to be mixed until further characterization is completed.
[b] 800 $yd^3$ (LLNL waste) stored pending WIPP availability.
[c] Evaporation ponds planned for treatment and storage.
[d] Capacity for either LLW or MLLW.
[e] 534 $yd^3$ was previously disposed.
[f] Includes 12,592 $yd^3$ from offsite.
[g] Lined lagoons or tanks planned for Liquid Waste Treatment System.
[h] Includes 9 $yd^3$ TSCA waste.
[i] Assumes 1,755 lb/$yd^3$.

Source: DOE 1992f; DOE 1993c; DOE 1993f; NT DOE 1993d; NT DOE 1993f; NT MMES 1993a; NT REECO 1994a; NTS 1993a:4.

waste from other DOE facilities. NTS manages the following waste categories: TRU, LLW, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

**Spent Nuclear Fuel.** NTS does not generate or manage spent nuclear fuel. However, NTS is being considered for this mission in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*, but it is not considered a preferred site by DOE.

**High Level Waste.** NTS does not generate or manage HLW.

**Transuranic Waste.** From 1974 to 1990, 800 $yd^3$ of mixed TRU waste was received from LLNL and is stored at Area 5 of NTS (NT DOE 1993f:37). DOE and the State of Nevada signed a Settlement Agreement on July 23, 1992, allowing the Nevada Operations Office to retain this inventory of mixed TRU waste subject to an appropriate permitting process. Since that time, the TRU waste has been characterized and repackaged and the mixed TRU waste has been placed in a RCRA-permitted storage area. However, these wastes were repackaged before RCRA characterization requirements were imposed on NTS. None of these waste packages are WIPP certified. They will have to be recertified prior to shipment to WIPP. These wastes will be stored at this area until WIPP is determined to be a suitable disposal facility pursuant to the requirements of 40 CFR 191 and 40 CFR 268, or another suitable repository is found. If WIPP is suitable, this mixed TRU waste will not have to be treated prior to disposal. NTS has areas of plutonium-contaminated soil, for which treatment technology is being developed. This activity probably will produce additional volumes of TRU or mixed TRU waste.

**Low-Level Waste.** LLW has been generated and disposed of in eight areas at NTS, but currently only Areas 3 and 5 are active for treatment, storage, and disposal. Bulk waste is disposed of in Area 3, and packaged classified and unclassified waste is disposed of in Area 5. Disposal of onsite waste began in 1971 and in 1978 operations expanded to receive wastes generated offsite. The offsite generators are currently revising their procedures to meet NTS waste acceptance criteria. As of December 1993, approximately 276,000 $yd^3$ of LLW have been disposed of in Area 3 (NT DOE 1993f:C-3) and approximately 219,900 $yd^3$ in Area 5 (NT REECO 1994a:12). Standard shallow land burial techniques have been employed.

**Mixed Low-Level Waste.** Disposal of mixed waste received from Rocky Flats Environmental Technology Site (formerly known as the Rocky Flats Plant) has taken place at NTS. This mixed waste disposal at NTS ceased pending issuance by the State of Nevada of a RCRA Part B permit for NTS. Environmental restoration could generate additional volumes of mixed wastes which will require some form of treatment. The Nevada Division of Environmental Protection provides RCRA oversight for NTS. The1992 revised RCRA Part B permit application to include a separate mixed waste storage and disposal unit at NTS, in accordance with the provisions of the *Federal Facility Compliance Act* of 1992, has been submitted to the State of Nevada.

**Hazardous Waste.** Hazardous wastes result from ongoing operations that utilize solvents, lubricants, fuel, lead, metals, motor oil, and acids. Hazardous wastes are accumulated at satellite areas and shipped offsite to a commercial RCRA-permitted facility. Additional accumulation areas are planned, and new equipment is planned to prevent the possibility of cross contamination with radioactive wastes (creating mixed wastes) in handling these materials. Hazardous waste generation is decreasing as the result of an aggressive waste minimization program, and will substantially decrease in the future due to the present moratorium on nuclear testing.

**Nonhazardous Waste.** Nonhazardous sanitary wastes are expected to be generated at the current rates for several years into the future, then decline assuming the present moratorium on underground weapons testing continues. Liquid nonhazardous wastes are disposed of in septic tanks, sumps, or in ponds, and solid wastes are disposed of in landfills at various locations on the site. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities.

### 4.3.3 Environmental Impacts

This section describes the environmental impacts of constructing and operating various tritium supply technologies and recycling facilities at NTS which are described in sections 3.4.1 and 3.4.2.1. It begins by describing potential impacts to existing and planned facilities at NTS, followed by descriptions of potential impacts and the environmental impacts of the proposed action on potentially affected environmental resources. The section concludes by describing the potential impacts of tritium supply and recycling on human health during normal operation and radiation and hazardous chemical accidents, and waste management impacts. Each description addresses the effects of No Action and the potential impacts and environmental impacts of constructing and operating a tritium supply and collocated recycling facility or a tritium supply facility alone at NTS.

#### 4.3.3.1 *Land Resources*

Construction and operation of a tritium supply technology and recycling facilities at NTS would affect land resources, including land use and visual resources. Potential impacts to the land resources are summarized below.

NTS has sufficient land area to accommodate any of the proposed tritium supply technologies and recycling facilities. The nearest offsite boundary to the proposed 600-acre TSS is 3.5 miles east and exceeds the requirement of a 1-mile buffer zone between plant operations and site boundary. The construction and operation of any of the tritium supply technologies would not change the existing landscape character at NTS. The following sections present the impacts of the proposed action on land resources.

**Land Use.**

*No Action.* Under No Action, no additional land use impacts are anticipated at NTS beyond the effects of existing and future activities which are independent of the proposed action.

*Tritium Supply and Recycling.* Any one of the tritium supply technologies and collocated tritium recycling facilities or tritium supply facilities alone (section 3.4), could be sited within the proposed TSS. Land requirements for the tritium facilities are presented in table 4.3.3.1–1. The land area affected ranges from 360 acres for the MHTGR to 173 acres for the APT. An additional 196 acres would be required if the tritium supply facility was collocated with a new recycling facility. Construction and operation of the tritium supply and collocated recycling facilities or the tritium supply facility alone would be consistent with the NTS Site Development Plan, and would not affect prime farmland, grazing allotments, other agricultural activities, or other land uses on the site. Land requirements during construction and operation would be largest for the MHTGR and the least for APT.

No tritium facilities would be constructed offsite, so offsite land use would not be directly affected. Land is available within the region and could be converted to residential developments to house workers. Such developments would be subject to local land use

**TABLE 4.3.3.1–1.—*Potential Changes to Land Use Resulting from Tritium Supply Technologies and Recycling at Nevada Test Site***

| | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|
| Indicator | HWR | MHTGR | ALWR[a] | APT[b] | Tritium Recycling |
| Land requirements[c] (acres) | 260 | 360 | 350 | 173 | 196 |
| Available land[d,e] (percent) | 0.3 | 0.4 | 0.4 | 0.2 | 0.2 |

[a] Land requirements for both Large and Small ALWR are the same.
[b] Land requirements for both Full and Phased APT are the same.
[c] Land area requirements are estimated to be the same for construction and operation.
[d] Undeveloped land reserved for development is approximately 100,000 acres.
[e] Any land requirement less than 100 percent means sufficient land.
Source: DOE 1992s; DOE 1994a; FDI 1993d; FDI 1994a; FDI 1994b; SNL 1993a.

controls and zoning ordinances, which vary by jurisdiction.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced capacity to meet a tritium supply requirement less than baseline, or the construction and operation of a Phased APT would not change potential baseline tritium requirement land use impacts. Land requirements would be the same in both operation scenarios.

*Potential Mitigation Measures.* Because proposed facilities would be sited within a designated development area consistent with the NTS site development plan, no mitigation measures are proposed.

**Visual Resources.**

*No Action.* Under No Action, the existing landscape character would remain unchanged, with a VRM classification of Class 4 (mixed use of industrial and open desert) for the main base and Class 2 for the undisturbed desert areas.

*Tritium Supply and Recycling.* Construction and operation of any of the proposed tritium supply technologies collocated with tritium recycling or alone would change the visual baseline VRM classification of the proposed site from Class 2 to Class 5. Of the tritium supply technologies, the APT would be less visually obstructive because of the low-profile buildings and cooling system (figure 3.4.2.4–1). Depending on final siting, the facilities could be visible from the wilderness study area portion of the Desert National Wildlife Range (refuge), approximately 10 to 13 miles away. This is a sensitive viewpoint. Because non-evaporative cooling systems are proposed for all reactor technologies at NTS, there would be little visual impact from plumes.

*Less Than Baseline Operations.* Baseline visual impacts would not change due to operation of the HWR, MHTGR, or ALWR at reduced tritium capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Mitigation measures could include siting the facilities so that views from the Desert National Wildlife Range are blocked by terrain (Massachusetts Mountain); and the use of architectural and landscape design and materials for the proposed facilities that would blend with, or complement, the existing landscape. Siting would be addressed in site-specific tiered NEPA documents.

### 4.3.3.2 *Site Infrastructure*

This section discusses site infrastructure for No Action and the modifications needed for actions due to construction and operation of new tritium supply and recycling facilities. A primary impact upon NTS due to the additional tritium facilities is the increase electrical power usage. A comparison of site infrastructure and facilities resource needs for No Action and the proposed tritium supply alternatives is presented in table 4.3.3.2–1.

**No Action.** The missions discussed in section 3.3.3 would continue under No Action. As shown in table 4.3.3.2–1, the site infrastructure would continue to adequately maintain the capability to resume underground nuclear testing in the event it is again required for national security. Facility improvements around the site would continue in a staged manner through 2014; however, overall operations would not increase.

**Tritium Supply and Recycling.** For those potential tritium supply technologies and recycling facilities that could be sited in the TSS, the electrical power loads range from 62 MWe to 566 MWe (table 4.3.3.2–2). The power requirements of the HWR, MHTGR, ALWR and APT each would require additional high-voltage transmission lines to be run from Las Vegas and electrical distribution and transmission equipment onsite. The alternatives would utilize between 0.53 and 4.79 percent of the regional power pool capacity margin. The additional power for the MHTGR could be supplied by the Nevada Power Company. The HWR and ALWR would require the Nevada Power Company to obtain additional power from the California and Southern Nevada Power Area. The APT would require the California and Southern Nevada Power Area to import more power via the Western Systems Coordinating Council. In all cases, approximately 62 miles of new connecting transmission lines from the Mercury area would be needed to provide power to the TSS. The tritium recycling facility conceptual design uses natural gas as a fuel source with an annual requirement of 7 million $ft^3$. This natural gas requirement is equivalent to approximately 46,000 gallons of fuel oil.

**TABLE 4.3.3.2–1.—*Modifications to Site Infrastructure for Tritium Supply Technologies and Recycling at Nevada Test Site***

| Alternative | Transportation | | Electrical | | Fuel[a] | | |
|---|---|---|---|---|---|---|---|
| | Roads (miles) | Railroads (miles) | Energy (MWh/yr) | Peak Load (MWe) | Oil (GPY)[b] | Natural Gas (million ft$^3$/yr) | Coal (tons/yr) |
| **Current Resources** | 400 | 0 | 168,500 | 35 | 1,510,000 | 0 | 0 |
| **No Action** | | | | | | | |
| Total site requirement | 400 | 0 | 168,500 | 28 | 1,510,000 | 0 | 0 |
| Change from current resources | 0 | 0 | 0 | -7 | 0 | 0 | 0 |
| **Heavy Water Reactor** | | | | | | | |
| Total site requirement | 402 | 120 | 796,500 | 113 | 3,267,000 | 0 | 0 |
| Change from current resources | 2 | 120 | 628,000 | 78 | 1,757,000 | 0 | 0 |
| **Modular High Temperature Gas-Cooled Reactor** | | | | | | | |
| Total site requirement | 402 | 120 | 616,500 | 90 | 1,726,500 | 0 | 0 |
| Change from current resources | 2 | 120 | 448,000 | 55 | 216,500 | 0 | 0 |
| **Large Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 402 | 120 | 1,356,500 | 184 | 1,806,000 | 0 | 0 |
| Change from current resources | 2 | 120 | 1,188,000 | 149 | 296,600 | 0 | 0 |
| **Small Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 402 | 120 | 836,500 | 119 | 1,716,000 | 0 | 0 |
| Change from current resources | 2 | 120 | 668,000 | 84 | 206,000 | 0 | 0 |
| **Full Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 404 | 120 | 3,996,500 | 594 | 1,619,200 | 0 | 0 |
| Change from current resources | 4 | 120 | 3,828,000 | 559 | 109,200 | 0 | 0 |
| **Phased Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 404 | 120 | 2,656,500 | 399 | 1,619,200 | 0 | 0 |
| Change from current resources | 4 | 120 | 2,488,000 | 364 | 109,200 | 0 | 0 |

[a] Oil is the primary utility fuel at NTS and all of the tritium supply and recycling fuel requirements have been converted to oil equivalents; Coal is assumed to be 14,000 British thermal units per pound, natural gas is assumed to be 1,000 British thermal units per ft$^3$, and fuel oil (8 lb/gal) is assumed to be 19,000 British thermal units per pound.

[b] Includes all petrochemicals.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NTS 1993a:4.

**TABLE 4.3.3.2–2.— *Impacts on Regional Electrical Power Pools from Tritium Supply Technologies and Recycling at Nevada Test Site***

| Tritium Supply Technology and Recycling | Peak Power Required (MWe) | Margin Capacity (percent) | Annual Energy Required (MWh) | Total Electricity Production (percent) |
|---|---|---|---|---|
| Heavy Water Reactor | 85 | 0.72 | 628,000 | 0.26 |
| Modular High Temperature Gas-Cooled Reactor | 62 | 0.53 | 448,000 | 0.18 |
| Large Advanced Light Water Reactor | 156 | 1.32 | 1,188,000 | 0.48 |
| Small Advanced Light Water Reactor | 91 | 0.77 | 668,000 | 0.27 |
| Full Accelerator Production of Tritium | 566 | 4.79 | 3,828,000 | 1.56 |
| Phased Accelerator Production of Tritium | 371 | 3.14 | 2,488,000 | 1.01 |

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; NTS 1993a:4.

Currently, NTS does not use natural gas; therefore, the equivalent amount of fuel oil is used for determining fuel impacts.

To connect the NTS road network with the TSS, approximately 2 miles of additional secondary access roads would be required for the HWR, MHTGR and ALWR. The APT would need approximately 4 additional miles of secondary access roads. Interconnection requirements for the tritium facilities within the TSS are not expected to change appreciably when specific site adaptations are completed. Should a rail connection be needed, the required minimum length of new rail and railbed would be approximately 120 miles. This would connect the TSS with a Union Pacific rail line.

**Tritium Supply Only.** If any of the tritium supply technologies were sited at the TSS without collocating tritium recycling, the electrical power loads associated with the technologies would decrease by 16 MWe or 88,000 MWh. Even with these smaller electrical loads, the HWR and ALWR would still require that the Nevada Power Company obtain additional power from the California and Southern Nevada Power Area. Similarly, the APT would still require the California and Southern Nevada Power Area to import more power via the Western Systems Coordinating Council. The fuel oil requirement (including the equivalent fuel oil requirement attributed to natural gas usage) would decrease by approximately 96,000 gallons.

**Less Than Baseline Operations.** In the event that only the steady state component of the baseline tritium requirement is required, the impacts for some tritium supply technologies on the site infrastructure would change. There would be no appreciable change for the HWR, MHTGR, and the ALWR technologies. The Phased APT would reduce electrical consumption by approximately 35 percent but the fuel, onsite transportation infrastructure, and power line requirements would not change.

**Potential Mitigation Measures.** Redesign of the tritium recycling facilities to use oil as a fuel alternative to designs which rely on natural gas and coal would preclude building new natural gas lines from offsite sources and both onsite and offsite infrastructure for coal.

Siting of new roads, railroad spurs, and utility infrastructure could follow existing rights-of-way to minimize impacts to natural resources. Where new rights-of-way would need to be constructed, alignments should consider existing sensitive habitat (e.g., wetlands, streams, and vegetation) to minimize the potential for impacting these resources.

#### 4.3.3.3 *Air Quality and Acoustics*

Construction and operation of a tritium supply and recycling facilities at NTS would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. To determine the air quality impacts, criteria and toxic/hazardous concentrations from each technology have been compared with Federal and state standards and guidelines. Impacts for radiological airborne emissions are discussed in section 4.3.3.9.

In general, all of the proposed technologies would emit the same types of air pollutants during construction. Emissions would typically not exceed Federal, state, or local air quality regulations or guidelines, except that $PM_{10}$ and TSP concentrations may be close to or exceed the 24-hour $PM_{10}$ and TSP standard during peak construction periods, which is not uncommon for large construction projects.

During operation, impacts from each of the individual tritium supply technologies and recycling facilities with respect to the concentrations of toxic/hazardous air pollutants are predicted to be in compliance with Federal, state, and local air quality regulations or guidelines. The estimated pollutant concentrations presented in table 4.3.3.3–1 for each of the tritium supply technologies and recycling facilities indicate little difference between technologies with respect to impacts to air quality.

The Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on the emission rates presented in appendix table B.1.4–2, Prevention of Significant Deterioration permits may be required for each of the proposed alternatives at NTS. This may require "offsets," reductions of existing emissions, to permit any additional or new emission source.

**TABLE 4.3.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Nevada Test Site***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | 2010 No Action ($\mu g/m^3$) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | HWR ($\mu g/m^3$) | MHTGR ($\mu g/m^3$) | ALWR ($\mu g/m^3$) | APT ($\mu g/m^3$) | Tritium Recycling ($\mu g/m^3$) |
| **Criteria Pollutant** | | | | | | | | |
| Carbon monoxide (CO) | 8-hour | 10,000 | 2,306 | 2,343 | 2,432 | 2,353 | 2,321 | 15 |
| | 1-hour | 40,000 | 2,816 | 2,972 | 3,344 | 3,012 | 2,876 | 61 |
| Lead (Pb) | Calendar Quarter | 1.5 | [a] | [a] | [a] | [a] | [a] | [a] |
| Nitrogen dioxide ($NO_2$) | Annual | 100 | 4 | 5 | 8 | 8 | 4 | 0.5 |
| Ozone ($O_3$) | 1-hour | 235 | [a] | [a] | [a] | [a] | [a] | [a] |
| Particulate matter ($PM_{10}$)[b] | Annual | 50 | 2 | 3 | 2 | 2 | 2 | 0.1 |
| | 24-hour | 150 | 104 | 107 | 106 | 106 | 105 | 1.4 |
| Sulfur dioxide ($SO_2$) | Annual | 80 | 2 | 2 | 2 | 2 | 2 | 0.01 |
| | 24-hour | 365 | 59 | 59 | 59 | 60 | 59 | 0.1 |
| | 3-hour | 1,300 | 216 | 219 | 218 | 221 | 217 | 0.8 |
| **Mandated by Nevada** | | | | | | | | |
| Total suspended particulates[b] | Annual | 75 | 2 | 3 | 2 | 2 | 2 | 0.1 |
| | 24-hour | 150 | 104 | 107 | 106 | 106 | 105 | 1.4 |
| **Hazardous and Other Toxic Compounds** | | | | | | | | |
| Acetone | 8-hour | 42,381 | [a] | [a] | [a] | 6.5 | [a] | [a] |
| Acetylene | 8-hour | [c] | [a] | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| Ammonia | 8-hour | 429 | [a] | [a] | [a] | 3.4 | [a] | [a] |
| Ethyl alcohol | 8-hour | 45,238 | [a] | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Methane | 8-hour | [c] | [a] | 2.1 | 2.1 | 2.1 | 2.1 | 2.1 |
| Methyl alcohol | 8-hour | 6,190 | [a] | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Nitric acid | 8-hour | 119 | [a] | 3.9 | [a] | 45.2 | [a] | [a] |
| 1,1,1-Trichloroethane | 8-hour | 45,238 | [a] | 0.7 | 0.2 | 14.9 | [a] | [a] |
| Trichlorotrifluoroethane | 8-hour | 18,095 | [a] | 27.4 | [a] | [a] | [a] | [a] |

[a] No sources indicated.

[b] It is conservatively assumed that all $PM_{10}$ concentrations are TSP concentrations.

[c] There is no standard.

Note: Concentrations for tritium supply and recycling include 2010 No Action concentrations. To determine the concentrations of pollutants from each tritium supply technology, subtract the pollutant concentration for tritium recycling from each of the tritium supply and recycling concentrations.

Note: DOE is committed to the phaseout of ozone-depleting substances and will discontinue use of those substances according to EPA phaseout schedules.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NT NAC 1991a; NTS 1993a:4.

Noise emissions during either construction or operation are expected to be low. Air quality and acoustic impacts for each technology are described separately. Supporting data for the air quality and acoustics analysis, including modeling inputs, are presented in appendix B.

**Air Quality.** An analysis was conducted of the potential air quality impacts of emissions from each of the tritium supply technologies and recycling facilities. The air quality modeling analysis used the Industrial Source Complex Short-Term model recommended by EPA. The resulting air quality conditions were evaluated against local and state air quality regulations, and NAAQS (40 CFR 50). The potential exceedance of Prevention of Significant Deterioration (40 CFR 52.21) increments for $PM_{10}$, $SO_2$, or $NO_2$ was also determined.

*No Action.* No Action utilizes estimated air emissions data from operations at NTS in the year 2010 assuming continuation of site missions as described in section 3.3.2. These data reflect conservative estimates of criteria and toxic/hazardous emissions at NTS. The emission rates for the criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.1.4–2. Table 4.3.3.3–1 presents the No Action concentrations. Pollutant concentrations are in compliance with all air quality regulations and guidelines. It is conservatively assumed that $PM_{10}$ concentrations are equal to TSP concentrations. The air quality at NTS in 2010 is expected to improve in comparison to the baseline air quality presented in section 4.3.2.3.

*Tritium Supply and Recycling.* Alternatives for NTS consist of four candidate technologies: HWR, MHTGR, ALWR and APT, alone or collocated with tritium recycling facilities. Air pollutants would be emitted during construction of the tritium supply technologies and recycling facilities. The principal sources of such emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant.

- Exhaust from, and road dust raised by, construction equipment, vehicles delivering construction material, and vehicles carrying construction workers.

$PM_{10}$ and TSP concentrations are expected to be close to or exceed the 24-hour ambient standard during the peak construction period. Exceedances would be expected to occur during dry and windy conditions. Appropriate control measures would be followed, such as watering to reduce emissions. With the exception of $PM_{10}$ and TSP, it is expected that concentrations of all other pollutants at the NTS boundary would remain within applicable Federal and state ambient air quality standards.

Air pollutant emission sources associated with the operation of each of the technologies include all or part of the following:

- Increased operation of existing boilers to generate additional steam for space heating.

- Operation of diesel generators and periodic testing of emergency diesel generators.

- Recycling operations.

- Exhaust from, and road dust raised by, vehicles delivering supplies and bringing employees to work.

Appendix table B.1.4–2 presents emissions from each of the proposed tritium supply technologies and recycling facilities. There are no gaseous releases associated with the APT (SNL 1995a), although emissions are associated with operation of the tritium supply facility included with the APT and with recycling facilities. Emissions from the Large ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Consequences from operation of each of the tritium supply technologies and recycling facilities at NTS are presented in table 4.3.3.3–1. Pollutant concentrations, combined with No Action concentrations, are in compliance with Federal and state standards.

Pollutant emissions resulting from the operation of tritium supply technologies alone (HWR, MHTGR, ALWR, and APT) consist of criteria pollutants from

the operation of boilers and diesel generators and toxic/hazardous pollutant emissions from facility processes. Criteria pollutant emissions from the MHTGR are the highest among the other tritium supply technologies and would increase existing total site criteria pollutant emissions by greater than 50 percent above No Action emissions. Concentrations of criteria and toxic/hazardous pollutants, added to No Action concentrations, are in compliance with Federal and State standards.

*Less Than Baseline Operations.* Air emissions from the HWR would be reduced slightly when operated at reduced capacity. However, the reduction would be negligible since most emissions are attributed to support equipment and facilities that are not related to the reactor operating level. The MHTGR or ALWR would have no change in air emissions because it would continue to operate at the same level as the baseline requirement to maintain power levels for steam or electrical production. The Phased APT construction and operation emissions and impacts would be the same as the Full APT.

*Potential Mitigation Measures.* Potential mitigation measures during construction include: watering to reduce dust emissions; applying non-toxic soil stabilizers to all inactive construction areas; cover, water, or apply non-toxic soil binders to exposed piles (i.e., gravel, sand, dirt); suspend all excavation and grading operations when wind speeds warrant; pave construction roads that have a traffic volume of more than 50 daily trips by construction equipment; use electricity from power poles rather than temporary gasoline and diesel power generators. Potential mitigation measures during operation include incorporating additional HEPA filters to reduce particulate emissions from processing facilities; substituting cleaning solvents for those which present health hazards or exceed the applicable standards; and switching from coal or fuel oil, to produce electricity or steam, to natural gas to reduce criteria pollutants.

**Acoustics.** The location of the tritium supply technologies and recycling facilities relative to the site boundary and sensitive receptors was examined to determine the contribution to noise levels at these locations and the potential for onsite and offsite impacts.

*No Action.* The continuation of operations at NTS would result in no appreciable change in traffic noise and onsite operational noise sources from current levels (section 4.3.2.3). Sources of nontraffic noise associated with current operations are located at sufficient distances from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

*Tritium Supply and Recycling.* Noise sources during construction may include heavy-construction equipment and increased traffic. Increased traffic would occur onsite and along major offsite transportation routes used to bring construction material and workers to the site.

Most nontraffic noise sources associated with operation of any of the tritium supply technologies and recycling facilities would be located at sufficient distance from offsite areas and the contribution to offsite noise levels would continue to be small. Due to the size of the site, noise emissions from construction and operation activities would not be expected to cause annoyance to the public.

Noise impacts associated with increased traffic on access routes would be considered in tiered NEPA documents. Some nontraffic noise sources associated with construction and operation of the tritium supply technologies and recycling facilities may be located close enough to offsite noise receptors to cause some increase in noise levels.

*Less Than Baseline Operations.* Baseline noise impacts would not change due to reactors operating at reduced capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Potential measures to minimize impacts on workers include the use of standard silencing packages on construction equipment and providing workers in noisy environments with appropriate hearing protection devices meeting OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

#### 4.3.3.4 *Water Resources*

Environmental impacts associated with the construction and operation of tritium supply technologies and

recycling facilities at NTS would affect surface water and groundwater resources. All water required for construction or operation would be supplied from groundwater. The proposed site for tritium supply and recycling facilities does not lie within areas historically prone to flooding. There are no continuous-flowing streams at NTS and no designated floodplains. During construction, treated sanitary wastewater would be discharged to containment and sewage ponds which would be built in accordance with applicable regulations to avoid impact on groundwater. While the potential impacts to surface waters during the construction phase would be erosion and sedimentation, the relatively dry climate and application of appropriate controls should preclude adverse impacts. All excess wastewater would potentially be disposed of in ponds that would be designed to minimize infiltration to groundwater. No wastewater would be discharged to surface waters during the operation of tritium facilities; therefore, no impacts to surface water quality are expected. Stormwater runoff would be collected and treated, if necessary, before discharge to natural drainage channels.

Table 4.3.3.4–1 presents existing surface water and groundwater resources and the potential changes to water resources at NTS resulting from the proposed tritium supply technologies and recycling facilities. Resource requirements for each tritium supply technology shown in this table represent the total requirements at the site, including No Action. Resource requirements for tritium recycling are added to these values to obtain the water resource requirements for assessing impacts associated with combined tritium supply and recycling.

**Surface Water.**

*No Action.* Under No Action, no impacts to surface water resources are anticipated since there are no surface water withdrawals, liquid discharges to navigable waters, offsite surface drainage systems, or publicly owned treatment works. A description of the activities that would continue at NTS is provided in section 3.3.3.

*Tritium Supply and Recycling.* No surface water would be withdrawn for any construction or operation activities associated with either the collocated tritium supply technologies and recycling facilities or the tritium supply alone. Consequently, impacts to surface water availability or surface water quality are not expected. Nonhazardous wastewater generated during construction and operation would either be recycled or treated and released to sewage or containment ponds that would be designed to minimize seepage. The potential impacts to surface waters during construction would be erosion of distributed land and sedimentation in drainage channels. To minimize soil erosion impacts, stormwater management and standard erosion control measures would be employed.

In most cases, impacts from runoff would be temporary and manageable. Nonhazardous wastewater, including sanitary wastewater, generated during the construction of either the collocated tritium supply and recycling facilities (which ranges from 28.4 MGY for the Large ALWR to 1.2 MGY for the APT), or the tritium supply facilities alone (which ranges from 27.5 MGY for the Large ALWR to 0.3 MGY for the APT) would be treated, as needed, and discharged to ponds, which would be constructed in accordance with applicable regulations to prevent infiltration into groundwater.

During operation, no effluents would be discharged to natural surface waters. Utility, process, and sanitary wastewater from the HWR, MHTGR, and ALWR would be treated prior to discharge into lined evaporation ponds. However, cooling system blowdown and sanitary wastewater from the APT would be treated and recycled for reuse as cooling system makeup. The treated effluent from the process treatment would be discharged to evaporation ponds. Treated effluent would be monitored to comply with the NPDES permit and other discharge requirements. The extent to which treated effluent or stormwater would be recycled for reuse within the plant would be determined during site-specific studies.

Stormwater runoff from either the collocated tritium supply and recycling facilities or the tritium supply facility alone would be collected in retention ponds. Runoff from site support facilities outside the main plant, except those that require onsite management measures by regulation such as sanitary wastewater plants and landfill areas, would be discharged directly to natural drainage channels. Uncontaminated runoff would be released to natural drainage

**TABLE 4.3.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Nevada Test Site***

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | | | Tritium Recycling[b] |
|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | |
| | | | | Large | Small | Full | Phased | |
| **Construction** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total water requirement (MGY)[c] | 633 | 654 | 651 | 666 | 653 | 641 | 641 | 1.5 |
| Percent increase in projected water use | 0 | 3 | 3 | 5 | 3 | 1 | 1 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to surface waters (MGY) or groundwater | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Percent change in stream flow from wastewater | NA | NA | NA | NA | NA | NA | NA | NA |
| NPDES permit required | NA | No | No | No | No | No | No | NA |
| **Operation** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total water requirement (MGY)[d] | 633 | 681 | 663 | 723 | 683 | 3,275 | 2,324 | 14 |
| Percent Increase in projected water use | 0 | 8 | 5 | 14 | 8 | 417 | 267 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to surface waters (MGY) or groundwater | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percent change in stream flow from wastewater | NA | NA | NA | NA | NA | NA | NA | NA |
| NPDES permit required | No | No | No | No | No | No | No | NA |
| **Floodplain** | | | | | | | | |
| Actions in 100-year floodplain | NA | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | NA |
| Critical actions in 500-year floodplain | NA | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | NA |
| Floodplain assessment required | NA | Yes | Yes | Yes | Yes | Yes | Yes | NA |

[a] Operational water requirements for MHTGR and ALWR technologies include utilization of steam turbine generators.

[b] Resource requirements for tritium recycling do not include No Action. The values presented in this column are added to the requirements of each tritium supply technology to assess the impacts associated with combined tritium supply and recycling.

[c] Total water requirements for construction at NTS are calculated by adding baseline requirements (633 MGY) with that for each tritium supply alternative: HWR (21.3 MGY), MHTGR (17.8 MGY), ALWR (33.3 MGY for Large and 20 MGY for Small), and APT (8.3 MGY).

[d] Total water requirements for operation at NTS are calculated by adding baseline requirements (633 MGY) with that for each tritium supply and recycling alternative: HWR (48 MGY), MHTGR (30 MGY), APT (1,691 MGY for Phased and 2,642 MGY for Full), and ALWR (90 MGY for Large and 50 MGY for Small).

Note: NA - not applicable.

Note: Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: FDI 1994h; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NTS 1993a:4; SR DOE 1995a.

channels. Contaminated stormwater runoff would be retained, treated in the radioactive waste treatment system, and released.

There are no designated floodplains at NTS, and the proposed site for the tritium facilities does not lie within areas historically prone to flooding. Because these operations may constitute a critical action, an assessment of the 500-year floodplain would be made in conjunction with the preparation of site-specific tiered NEPA documents before construction.

*Less Than Baseline Operations.* Baseline surface water impacts described above for the construction and operation phases would not change due to changes in reactor tritium operating capacity or construction and operation of a Phased APT.

*Potential Mitigation Measures.* No mitigation measures have been identified in addition to those implemented during construction for erosion and sediment control. Stormwater measures include stabilization practices that cover soils with materials such as vegetation, riprap, or mulch in order to prevent direct exposure of soils to runoff, and structural controls to divert flow away from disturbed areas include silt fences, dikes, and sediment traps. The dry climate and application of appropriate management measures should preclude potential adverse impacts during operation from stormwater runoff.

**Groundwater.**

*No Action.* Under No Action, no additional impacts to groundwater availability or quality are anticipated beyond the effects of existing and future activities that are independent of and unaffected by the proposed action.

**Groundwater Availability And Use.**

*Tritium Supply and Recycling.* Groundwater required for construction of either a collocated tritium supply and recycling facility or a tritium supply facility alone would represent approximately a 5-percent maximum increase over the projected groundwater withdrawal, would be within NTS's allotment, and would not be expected to cause depletion of the aquifer. Groundwater required for both construction and operation and the percent increase in projected water use are shown in table 4.3.3.4–1.

As discussed in section 4.3.2.4, two annual recharge rates of 2,300 MGY and 5,200 MGY to the aquifer used by NTS have been estimated by two separate studies. Based on these recharge estimates, total groundwater withdrawals required for the operation of the HWR, MHTGR, and ALWR, would remain below the lower recharge estimate. Operation of a Full APT with tritium recycling at 3/8 capacity would require a total site groundwater withdrawal of 3,275 MGY, which would exceed the lower estimate by 42 precent. However, the more likely scenario for the APT would be to operate at 3/8 level for 5 years (requiring groundwater withdrawals of 2,656 MGY), operating at 3/16 capacity for 30 years (requiring 1,705 MGY), and not operating for 5 years. Over the 40-year operating period, the average withdrawal would be 1,611 MGY, resulting in a total site groundwater withdrawal of 2,244 MGY which would be less than the lower estimated recharge rate. As discussed in section 4.3.2.4, hydrogeologic evidence suggests that part of the regional aquifer discharges into Devil's Hole Cavern, located approximately 34 miles downgradient from the site. Considering aquifer recharge and the distance between Devil's Hole and the proposed area, the wells servicing the proposed TSS would likely not impact the water levels at Devil's Hole (NT DOE 1993b:4-27).

*Less Than Baseline Operations.* Operation of the HWR at reduced capacity to meet a tritium supply requirement less than baseline would not change the operating water requirements or the quantity of water discharges. The MHTGR or ALWR water requirements and discharges would not change from the baseline; therefore the potential impacts would remain the same.

Operation of the Phased APT would require 2,324 MGY (table 4.3.3.4–1), a 267 percent increase over projected No Action water use. This is approximately two thirds of the 3,275 MGY required by the Full APT. The water requirement for the Phased APT is less than or approximately equal to both estimated recharge rates for the aquifer used by the NTS and should have no impact on water levels at Devil's Hole. All other requirements of the Phased APT are identical to those of the Full APT.

**Groundwater Quality.**

*Tritium Supply and Recycling.* Under normal construction and operating conditions sanitary wastewater disposed to the leach field would be the only discharge that would have a potential to reach the Valley-Fill aquifer. The wastewater would not have a measurable effect on groundwater quality because of the combined effects of a deep water table, low discharge volumes, high evaporation rates, and a composition and concentration consistent with treated and monitored sanitary wastewater.

*Less Than Baseline Operations.* Potential groundwater quality impacts described above would not change due to changes in reactor tritium operating capacities or the construction and operations of a Phased APT.

*Potential Mitigation Measures.* Possible mitigation to minimize potential local groundwater withdrawal impacts could include deepening existing water wells and drilling new wells in other areas.

### 4.3.3.5 *Geology and Soils*

Construction of tritium supply and recycling facilities at NTS would have no impact on geological resources described in section 4.3.2.5. Although a moderate seismic risk exists for these facilities, this would be considered in the design of the structures. The existing seismic risk does not preclude safe construction and operation of the tritium facilities. The only other geological hazard present is volcanic activity, which is improbable and is not anticipated to impact the proposed facilities. Construction would disturb up to a few hundred surface acres of soil, the amount depending on the tritium supply technology and recycling facilities. Control measures would be used to minimize soil erosion. Impacts would depend on the specific soil units in the disturbed area, the extent of land disturbing activities, and the amount of soil disturbed. Potential changes to geology and soils associated with the construction and operation of tritium supply and recycling facilities at NTS are discussed below.

*No Action.* Under No Action, DOE would continue current and planned activities at NTS. Any impacts to geology and soils from these actions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Construction activities would not affect geologic conditions. Design of the facilities would ensure that they would not be adversely affected by geologic conditions.

There are no known capable faults that cross the proposed TSS. The Cane Spring fault, located approximately 5 miles south of the Device Assembly Facility, is regarded as the most probable source for seismic activity in the vicinity of the TSS, although a number of smaller faults are inferred in the alluvial areas of the site and in the Massachusetts Mountain area. The Yucca fault, which is located north of the proposed TSS, is regarded as capable and is also a potential source of seismic activity. The location of a tritium supply and collocated recycling facilities or tritium supply facility alone would be evaluated at NTS during site-specific studies so that these capable faults and the associated potential ground rupture would be considered in facilities design. Ground shaking is more likely. Intensities of approximately VII on the modified Mercalli scale are possible at NTS. A peak ground acceleration of 0.67g with a Richter magnitude of 6.7 has been estimated for the Cane Spring fault, with a recurrence interval of 10,000 to 30,000 years. This would affect the integrity of poorly designed or nonreinforced structures but should not affect newly designed facilities. Based on the seismic history of the area, a moderate seismic risk exists at NTS but should not preclude safe construction and operation of a tritium supply and collocated recycling facilities or tritium supply facility alone. In addition, facilities would be designed for earthquake-generated ground acceleration in accordance with DOE Order 5480.28 and accompanying safety guides.

Although there is a history of past volcanism in the NTS area, volcanic eruptions are improbable (section 4.3.2.5). The most likely danger is from possible ash fall eruptions from the Long Valley area, 150 miles to the west-northwest. Lava extrusion from sources at NTS could recur but is highly unlikely. Precursors, such as shallow earthquakes, fumarole activity, and higher groundwater temperatures, provide advance warning of most eruptions; no such activity is currently indicated at NTS or the immediate vicinity.

It is highly unlikely that landslides, sinkhole development, or other nontectonic events would affect project activities. Slopes and underlying foundation materials are stable. Potential health impacts from accidents associated with geological hazards are discussed in section 4.3.3.9.

Properties and conditions of the soils underlying the proposed site have no limitations on construction. Soils would be impacted by construction and operation of the facilities. The amount of acreage that would be potentially disturbed by the tritium supply technologies and tritium recycling facilities is shown in table 4.3.3.1–1. Soils, therefore would not adversely effect the safe operation of project activities.

The soil disturbance from construction of new facilities could be as much as 562 acres for a MHTGR collocated with recycling facilities. Disturbance would occur at building, parking, and construction laydown areas, destroying the soil profile, and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and, particularly during the construction period, when soil is bare. Construction of both the MHTGR and the APT would also necessitate deep excavations to accommodate reactor modules and an accelerator tunnel, respectively (see sections 3.4.2.2 and 3.4.2.4). A considerable volume of soil would be removed as a result of excavations. Most of the material removed would be alluvial fan sediment and could be stockpiled for use as fill. Some of this material could be used to cover the accelerator tunnel of the APT. Site-specific NEPA studies would evaluate in detail impacts to geology and soils at NTS resulting from deep excavations required for the MHTGR and the APT and would identify appropriate mitigation measures.

Net soil disturbance during operation would be less than for construction, because areas temporarily used for laydown would be restored. Although erosion from stormwater runoff and wind action could occur occasionally during operation, it is anticipated to be minimal.

Appropriate erosion and sediment control measures would be used to minimize soil loss. Wind erosion is likely to occur on an intermittent basis, depending on wind velocities, the amount of soil exposed, and the effectiveness of control measures.

*Less Than Baseline Operations.* Under the less than baseline tritium operation, geology and soil impacts would not change for the HWR, MHTGR, or ALWR technologies. Disturbed acreage for the Phased APT would be the same as the baseline tritium requirement case Full APT, therefore impacts would be the same.

*Potential Mitigation Measures.* Mitigation measures would be required to control erosion from exposed areas of soil during construction. Potential mitigation measures include standard practices for erosion, sediment, and dust control from construction sites such as silt fences, sediment traps, runoff diversion dikes, drainageways, sedimentation ponds, establishment of ground cover and windbreaks, grading of slopes, and construction of berms, or other controls appropriate to the sites. Standard control for wind erosion, such as wetting the surface, would be done on a day-to-day basis. Exposing only small areas for limited periods of time would also reduce erosional effects. After the construction period, long-term control measures could include grading, revegetation, or landscaping.

#### 4.3.3.6 *Biotic Resources*

Construction and operation of tritium supply technology and recycling facilities at NTS would affect biotic resources. Impacts resulting from the construction of the HWR, MHTGR, ALWR, or Full APT to meet the baseline tritium requirement would occur only at the beginning of the project life cycle. The less than baseline tritium requirement for the Phased APT could incur some additional construction-related impact if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion would occur in the already developed main plant site. Impacts to terrestrial resources would result from the loss of habitat during construction and operation. Impacts to wetlands and aquatic resources would not occur since these resources are not located on the proposed TSS. The desert tortoise is the only Federal-listed species on the proposed TSS. Construction and operation

could pose a threat to both individual tortoises and their habitat. Where potential conflicts could occur, mitigation measures would be developed in consultation with USFWS. Consultation would be conducted at the site-specific level in tiered NEPA reviews. Table 4.3.3.6–1 summarizes the potential changes to biotic resources at NTS resulting from the proposed action. As noted in the table, no major differences in impacts to biotic resources exist among the four tritium supply technologies and recycling facilities.

**Terrestrial Resources.**

*No Action.* Under No Action, the missions described in section 3.3.2 would continue at NTS. This would result in no change to current terrestrial resource conditions at NTS described in section 4.3.2.6.

*Tritium Supply and Recycling.* Construction and operation of the HWR, MHTGR, ALWR, or APT and recycling facilities at the proposed TSS would result in the disturbance of approximately 462, 562, 552, or 375 acres, respectively, of terrestrial resources or less than 0.07 percent of NTS (table 4.3.3.1–1). These acreages include areas on which facilities would be constructed, as well as areas revegetated following construction. Vegetative cover within the proposed TSS area is primarily creosote bush (figure 4.3.2.6–1), and would be destroyed during land clearing operations. Creosote bush communities are well represented on NTS.

Constructing any of the tritium supply technologies and recycling facilities would have some adverse effects on animal populations. Less mobile animals, such as reptiles and small mammals, within the project area would be destroyed during land clearing activities. Larger mammals and birds in construction and adjacent areas would be disturbed and would move to similar habitat nearby. The long-term survival of these animals would depend on whether the area to which they moved was at or below its carrying capacity. Nests and young animals living within the proposed TSS could be lost during construction. Areas disturbed by construction but not occupied by facility structures would be of minimal value to wildlife because of the difficulty in establishing vegetative cover in a desert environment.

Activities associated with operation, such as noise and human presence, could affect wildlife living immediately adjacent to the tritium supply and recycling facilities. These disturbances may cause some species to move from the area.

A dry cooling design is proposed for all tritium supply technologies at NTS except for the APT. While there would be no impacts to vegetation from

**TABLE 4.3.3.6–1.—*Potential Impacts to Biotic Resources Resulting During Construction and Operation from Tritium Supply Technologies and Recycling at Nevada Test Site***

| | | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| **Affected Resource Indicator** | **No Action** | **HWR** | **MHTGR** | **ALWR** | **APT** | **Tritium Recycling** |
| Acres of habitat disturbed | 0 | 462[a] | 562[a] | 552[a] | 375[a] | 202 |
| Wetlands potentially impacted | None | None | None | None | None | None |
| Aquatic resources potentially impacted | None | None | None | None | None | None |
| Number of threatened and endangered species potentially affected[b] | 0/0 | 1/12 | 1/12 | 1/12 | 1/12 | 1/12 |

[a] Acreage disturbed by each tritium supply technology may be obtained by the subtracting the acreage for the tritium recycling facility from the tritium supply technologies and recycling acreage.

[b] The number of threatened and endangered species are represented by two data inputs (a/b) where: a - the number of Federal-listed threatened and endangered species, and b - the number of all other special status species (i.e., Federal candidate and/or state-listed species) that are potentially impacted.

Source: FDI 1993a.

salt drift from an HWR, MHTGR, or ALWR, this may not be the case for the APT. A total of 10 separate cooling towers would be located along the length of the facility (section 3.4.2.4). Since design parameters for these towers are not known at this time, it is not possible to estimate impacts. This would be determined in future tiered NEPA documentation.

Construction and operation of a stand alone tritium supply facility would result in impacts to terrestrial resources that would be similar to, but less than, those described for a collocated tritium supply and recycling facility. Impacts would be less since 202 fewer acres of habitat would be disturbed.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have the same impacts described above for production at baseline tritium requirements.

Construction-related impacts of the less than baseline tritium requirement and Phased APT would be similar to those described above. Some additional construction-related impacts could occur if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion activities would occur in the already developed main plant site.

*Potential Mitigation Measures.* Habitat disturbance would be held to a minimum because of the difficulty in establishing plant cover in a desert environment. Disturbance to wildlife living in areas adjacent to any of the facilities may be lessened by preventing workers from entering undisturbed areas. It may be necessary to survey the TSS for the nests of migratory birds or eagles prior to construction and/or avoid clearing operations during breeding seasons.

**Wetlands.**

*No Action.* Under No Action, the missions described in section 3.3.2 would continue at NTS with no changes to wetlands at NTS.

*Tritium Supply and Recycling.* Construction and operation of any of the tritium supply technologies and recycling facilities would not affect wetlands because there are no wetlands in the proposed TSS. Construction and operation of a stand alone tritium supply facility would not affect wetlands because there are no wetlands in the proposed TSS.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have no wetland impact. Construction and operation of a Phased APT would also not affect wetlands because there are no wetlands in the proposed TSS.

*Potential Mitigation Measures.* Mitigation measures are not anticipated.

**Aquatic Resources.**

*No Action.* Under No Action, the missions described in section 3.3.2 would continue at NTS. Impacts to aquatic resources would not occur because of the lack of permanent surface water at NTS.

*Tritium Supply and Recycling.* Construction and operation of any of the tritium supply technologies and recycling facilities would not affect aquatic resources because there are no permanent surface water bodies in the proposed TSS. Temporary aquatic habitat may develop in evaporation and retention ponds, as well as in natural channels in the immediate vicinity of NPDES permitted outfalls. Construction and operation of a stand alone tritium supply facility would not affect aquatic resources because there are no permanent surface water bodies.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would not impact aquatic resources a NTS. Construction and operation of a Phased APT would also not impact aquatic resource because there are no permanent surface water bodies in the proposed TSS.

*Potential Mitigation Measures.* Mitigation measures are not anticipated.

**Threatened and Endangered Species.**

*No Action.* Under No Action, the alternatives described in section 3.3.2 would continue at NTS. Since underground nuclear testing has been

suspended, impacts to threatened and endangered species are not expected.

*Tritium Supply and Recycling.* The threatened desert tortoise is the only Federal-listed species that could be affected by construction of tritium supply and recycling facilities at NTS. During construction, clearing operations, trenches, and excavation could pose a threat to any tortoises residing within the disturbed area. An increase in vehicle traffic is an additional hazard to the tortoise. Measures designed to avoid impacts to the desert tortoise from previous projects at NTS have been implemented as a result of a Biological Opinion issued by USFWS (NT FWS 1992a). Similar measures (see potential mitigation measures) would be followed if tritium supply and recycling facilities were constructed at NTS.

Several Federal candidate Category 2 species may also be affected by construction. The ferruginous hawk could lose foraging habitat and the loggerhead shrike could lose foraging and breeding habitat. Neither species would, however, be adversely impacted due to the abundance of nearby suitable habitat. Any plant species included in table 4.3.2.6–1 that are located within the construction area would be destroyed during land clearing activities. Pre-activity surveys would be required prior to construction to determine the occurrence of these species in the area to be disturbed.

During facility operation, vehicle traffic would pose a hazard to the desert tortoise similar to that of current traffic. Extensive measures are presently being taken to ensure that drivers on the NTS avoid the tortoise. The ferruginous hawk would be discouraged from utilizing areas in close proximity to the operating facility but the loggerhead shrike could take advantage of the bordering fences as perching and hunting sites. Groundwater levels in Devil's Hole Cavern are not expected to change due to operation of the tritium supply and recycling facility (section 4.3.3.4); therefore, impacts to the Devil's Hole pupfish are not expected. Similarly, other rare endemic aquatic species found in the Ash Meadows area would not be affected.

Construction and operation of a tritium supply facility alone would result in similar impacts to threatened and endangered species, but less than those described for a collocated tritium supply and recycling facility. Impacts would be less since fewer acres of habitat would be disturbed.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have similar impacts on the Federal listed desert tortoise and candidate species as discussed above for the baseline tritium production requirement. Construction and operation of a Phased APT would also have similar impacts as discussed above.

*Potential Mitigation Measures.* Disturbance of threatened, endangered, and special status species would be avoided where possible and mitigation plans developed as required. A Biological Opinion concerning the desert tortoise has been issued by the USFWS covering current projects (NT FWS 1992a). Recommended mitigation measures included surveys for the desert tortoise and their removal from affected areas, as well as periodic inspections and eventual backfilling, covering, or installation of tortoise-proof fencing around open construction trenches and excavations and reducing speed limits on site roadways. Similar USFWS recommendations would be considered if NTS were selected as the location for the tritium supply and recycling facilities.

Land clearing activities could be scheduled to avoid the nesting season of the loggerhead shrike or avoided in areas where sensitive plant species occur. Where appropriate, habitat restoration or propagation programs would be attempted for plants when their disturbance is unavoidable. Consultation with USFWS would be required if any threatened or endangered species would be disturbed. No critical habitat has been designated for the tortoise or other threatened and endangered species at NTS.

### 4.3.3.7 *Cultural and Paleontological Resources*

Cultural and paleontological resources may be affected directly through ground disturbance during construction, visual intrusion of the project to the historic setting or environmental context of historic sites, visual and audio intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Intensive cultural resources inventories and site evaluations have not been conducted for the majority of

the proposed TSS. Site-specific surveys and evaluations would be conducted in conjunction with tiered NEPA documentation. Although the location and acreage for the proposed tritium supply plant or the combined tritium supply and recycling facilities will vary, the effects on cultural and paleontological resources are based primarily on the amounts of ground disturbance; therefore, the facilities with the greatest ground disturbance will have the greatest potential effect on cultural and paleontological resources. Some NRHP-eligible prehistoric and historic sites, important Native American resources and scientifically important paleontological resources may be affected by the proposed action.

**Prehistoric and Historic Resources.**

*No Action.* Under No Action existing and planned missions at NTS would continue. Any impacts to prehistoric and historic resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Land disturbance for the proposed tritium facilities (section 3.4) would range from 360 acres for the MHTGR to 173 acres for the APT (section 4.3.3.1). Acreages for the HWR and ALWR would be 260 and 350, respectively. Acreage required by the recycling facilities would be an additional 196 acres. Some NRHP-eligible prehistoric and historic sites may occur within the acreages that would be disturbed during construction. The prehistoric sites may include temporary camps, milling stations, habitation sites, quarries, and limited activity locations. The historic sites may include mines, campsites, trails, and trash dumps. NRHP-eligible resources will be identified through project specific inventories and evaluations, and any project related effects would be addressed in site-specific tiered NEPA documents. Operation of new facilities would not involve additional ground disturbance or increased activity; therefore, prehistoric or historic sites would not be affected.

*Less Than Baseline Operations.* No change in impacts to prehistoric and historic resources would be expected from operating the HWR at reduced capacity. Impacts for the MHTGR or ALWR would also not change from those described for the baseline requirement because the MHTGR or ALWR would not be a reduced size or operate at reduced capacity. Construction and operation of the Phased APT would not change the expected impacts from the baseline tritium requirement technologies since the disturbed area would be the same.

*Potential Mitigation Measures.* If NRHP-eligible resources cannot be avoided through project design or siting, and would result in an adverse effect, then a Memorandum of Agreement would need to be negotiated between DOE, the Nevada SHPO, and the Advisory Council on Historic Preservation describing and implementing intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs. The appropriate level of data recovery for mitigation would be determined through the Nevada SHPO and the Advisory Council on Historic Preservation, in accordance with Section 106 of the *National Historic Preservation Act.*

**Native American Resources.**

*No Action.* Under No Action existing and planned missions at NTS would continue. Any impacts to Native American resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Some Native American resources may occur within the acreages that would be disturbed during construction of the tritium facilities. Native American resources may include burials, ceremonial sites, petroglyphs (rock art), and traditional plant gathering areas. Operation of facilities may create audio or visual intrusions on Native American sacred sites in the vicinity or reduce access to traditional use areas. Specific concerns about the presence, type and locations of Native American resources would be identified through consultation with the potentially affected Native American tribes, and any project related effects would be addressed in tiered NEPA documents.

*Less Than Baseline Operations.* Impacts to Native American resources would not change due to less than baseline operation of the HWR, MHTGR, or ALWR. Construction and operation of a Phased APT would have similar impacts on Native American resources as those described for the baseline requirement Full APT.

*Potential Mitigation Measures.* If Native American resources cannot be avoided through project design or siting, then acceptable mitigations to lessen the effect on these resources would be determined in consultation with all potentially affected Native American groups. Such mitigations may include, but not be limited to, appropriate relocation of human remains according to the *Native American Graves Protection and Repatriation Act,* planting vegetation screens to reduce visual and noise intrusions, increased access to traditional use areas during operations, or transplanting or harvesting sensitive Native American plant resources. However, impacts to some Native American resources such as rock art sites may be mitigated, as appropriate.

**Paleontological Resources.** Some late Pleistocene paleontological resources may occur within the acreages that would be disturbed during construction of the tritium facilities. In such a case, paleontological monitoring of construction activities may be an appropriate mitigation, since scientifically important paleontological materials may be affected.

*Less Than Baseline Operations.* No change in impacts to paleontological resources would be expected due to reduced operation of the HWR, MHTGR, or ALWR. Construction of a Phased APT may potentially have a slightly smaller impact on paleontological resources due to less excavation for APT tunnel length.

#### 4.3.3.8 *Socioeconomics*

Locating any of the tritium supply technologies alone or with recycling facilities at NTS would affect socioeconomics in the region. Section 3.2 provides descriptions for No Action, the tritium supply technologies, and tritium recycling. Siting a tritium supply technology with or without a recycling facility at NTS would result in changes in some of the communities in both the ROI and the economic study area. The in-migrating population could increase the demand for housing units. Additionally, there would be an associated increased burden on community infrastructure and subsequent effects on the public finances of local governments in the ROI. The increase of population could also burden transportation routes in the ROI.

Locating the ALWR at NTS would create the greatest changes during construction, but locating the HWR, MHTGR, or ALWR would result in similar changes during operation. The APT would cause the fewest changes of the tritium supply technologies. None of these tritium supply technologies with a recycling facility would increase population, the need for additional housing, or local government spending in the ROI spending beyond 3 percent over No Action during peak construction or operation. Although the greatest percent increases in employment, population and housing, and public finance during construction and operation occur in the peak years of 2005 and 2010, respectively, the annual average increases over the construction period (2001 to 2005) are between 1 and 5 percent average growth annually. Between peak construction and full operation (2005 to 2010), annual average increases vary from decreases of less than 1 percent to increases between 1 and 2 percent. During operation (2010 to 2050), annual average growth is between 1 and 2 percent. None of the annual average increases associated with tritium supply technologies and recycling facilities constitutes a major difference from the No Action annual average increases.

The effects of locating any of the tritium supply technologies alone or with recycling facilities at NTS are summarized in section 4.3.3. The following sections describe the effects that locating one of these technologies would have on the local region's economy and employment, population, housing, public finances, and local transportation.

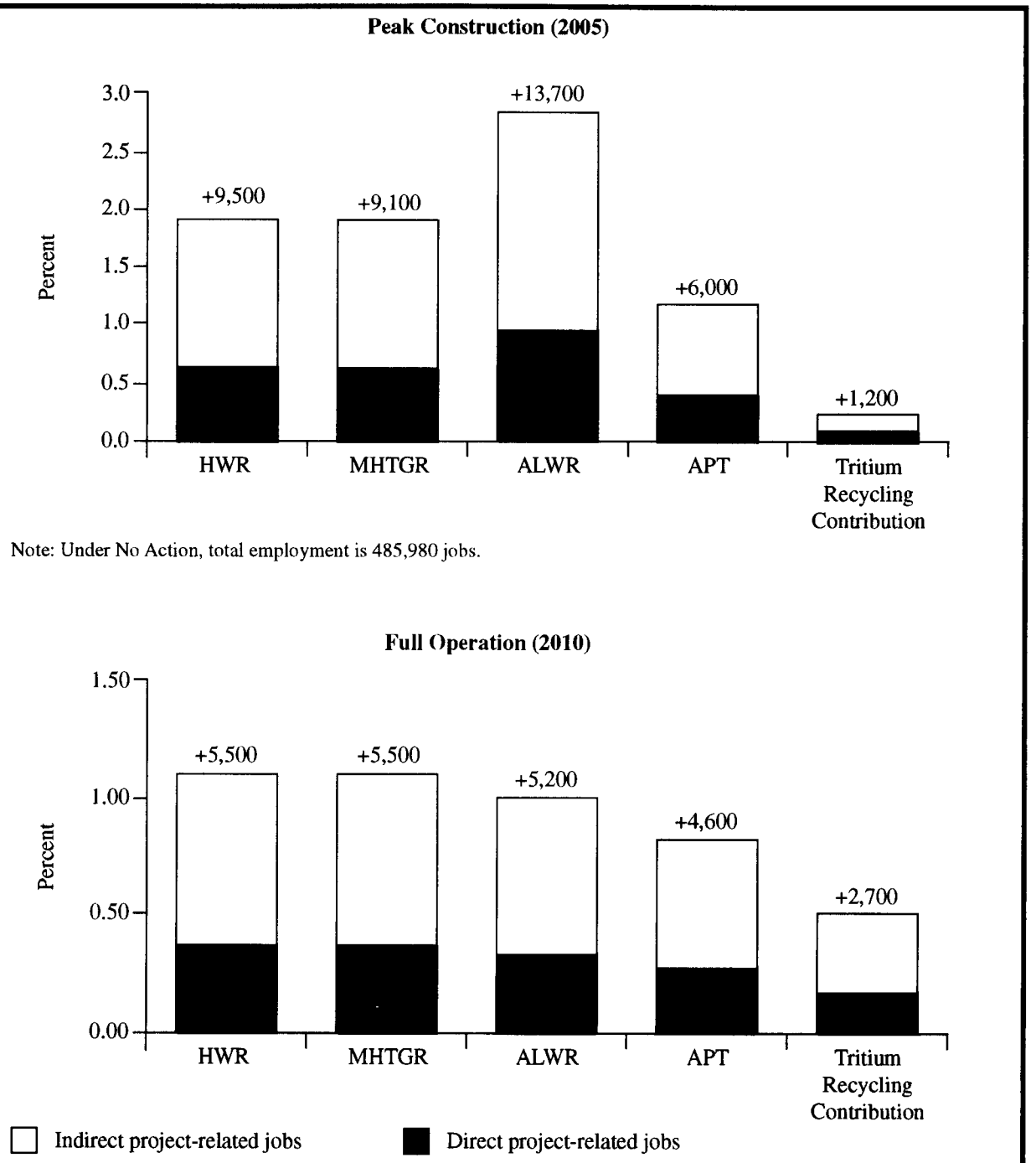
**Employment and Local Economy.** Changes in employment and levels of economic activity in the 4-county economic study area from the proposed action at NTS are described in this section. Although specialized personnel, materials, and services required for construction and operation would be imported from outside the area, a significant portion of these requirements would be available in this economic study area. Figures 4.3.3.8–1 and 4.3.3.8–2 present the potential changes in employment and local economy that would occur with each of the technologies.

*No Action.* Under No Action, employment at NTS decreased to 6,850 persons in 1994. This is a decrease of approximately 1,170 persons from the 1990 employment. NTS employment is projected to remain at 6,850 through 2020. Historical and future employment projections at NTS are found in appendix table D.2.1–1. The total NTS payroll was approximately $276 million in 1994 and is expected to continue at this level through 2010.

Total employment in the economic study area is projected to grow 1 percent annually between 2001 and 2009, reaching 509,500 persons, and less than 1 percent annually between 2010 and 2020, reaching 525,900 persons. The unemployment rate in the economic study area is expected to remain at 5.0 percent between 2001 and 2020. Per capita income is projected to increase from $23,600 to $25,100 during this 20-year period. No Action estimates are presented in appendix table D.3–22.

*Tritium Supply and Recycling.* Construction activities would begin between the years 2001 and 2003 and would be completed between the years 2007 and 2009. Phasing in of employment for the operation of the new facilities would begin in the year 2007, peak at full employment by the year 2010, and continue at this level into the future.

Locating any of the tritium supply technologies and recycling facilities at NTS would create new jobs (direct) at the site. Indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new jobs. The total new jobs (direct and indirect) created would reduce unemployment and increase income in the economic region surrounding NTS during both the




Note: Under No Action, total employment is 485,980 jobs.

Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. Under No Action, total employment is 515,570 jobs. The percent increase in total employment during peak construction and full operation was calculated by dividing the total project-related jobs by the total employment under No Action.

Source: Appendix table D.3–24.

**FIGURE 4.3.3.8–1.—*Total Project-Related Employment (Direct and Indirect) and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling for Nevada Test Site Economic Study Area.***

construction and operation periods of the proposed action.

Construction. Siting tritium supply technologies and recycling facilities at NTS would require a total of approximately 4,400 to 13,600 worker-years of activity over a 5- to 9-year construction period. This construction-related employment would indirectly create other jobs in the economic study area and total employment would grow at an annual average rate of 1 to 2 percent until the peak year of 2005. Between 2005 and 2010, annual growth would increase between 1 and 2 percent. Figure 4.3.3.8–1 gives the estimates of total jobs (direct and indirect) that would be created during peak construction (year 2005) for each of the tritium supply technologies with recycling, and the recycling facility's contribution to employment growth.

As employment opportunities grow in the economic study area due to the proposed action, the unemployment rate would be reduced from the No Action estimate of 5 percent. Figure 4.3.3.8–2 presents a comparison of unemployment rates for the different tritium supply technologies and recycling facilities during peak construction in the year 2005. During the project's peak construction phase, the unemployment rate would range from 3.9 to 4.0 percent depending on the tritium supply technologies with recycling selected.

Income in the economic study area would also increase slightly over No Action, particularly during peak construction as shown in figure 4.3.3.8–2. Per capita income is expected to increase at an annual average of 1 percent until the peak construction year (2005). Between 2005 and 2010, per capita income would also increase by 1 percent. The No Action annual average increase for per capita income is 1 percent until 2005 and less than 1 percent between 2005 and 2010.

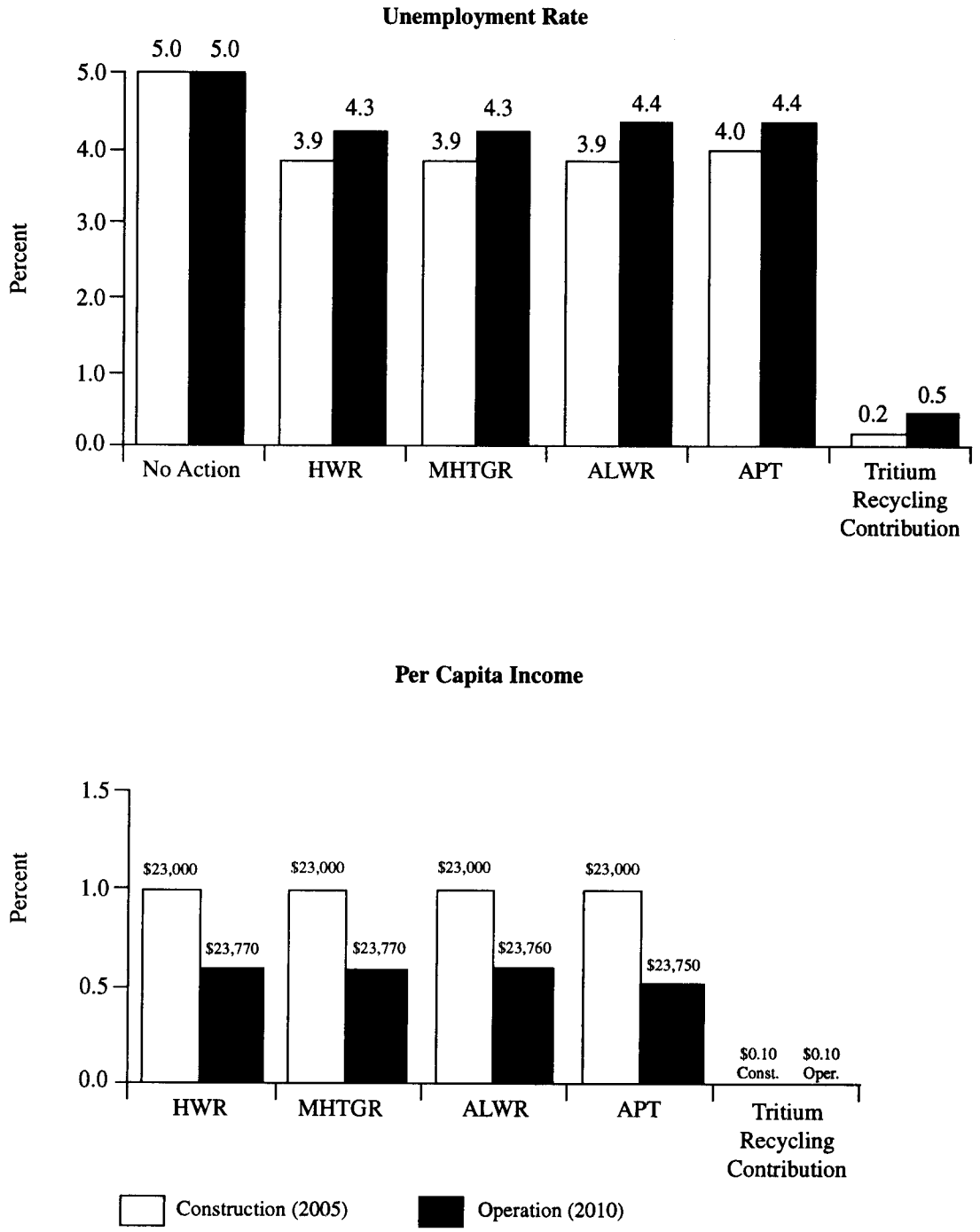
Operation. Employment for operation would begin phasing in as construction nears completion and the construction-related employment begins phasing out. It is expected that full operation employment would peak in the year 2010 and continue at this level for the life of the operation. Figure 4.3.3.8–2 gives the total project-related jobs projections (direct and indirect) for each of the tritium supply technologies and recycling facilities for the year 2010. Total employment growth from 2010 to 2020 would be flat.

Creation of additional job opportunities would reduce the unemployment rate below that projected for No Action. Figure 4.3.3.8–2 presents the differences in unemployment rates during the first year of full operation employment (2010) for each of the tritium supply technologies and recycling facilities. From the years 2010 to 2020, unemployment would be reduced from the No Action projection of 5.0 percent to between 4.3 and 4.4 percent, depending upon the technology selected for the proposed action.

Income would also increase slightly over No Action in the economic study area as a result of the proposed action. Per capita income differences for tritium supply technologies and recycling facilities for the year 2010 are given in figure 4.3.3.8–2. Per capita income annual average increases would be about 1 percent between the years 2010 to 2020 for all of the tritium supply technologies and recycling facilities considered for location at NTS. The No Action projected annual average increase during the same period would also be approximately 1 percent.

*Tritium Supply Alone.* Construction of the tritium supply technologies without recycling facilities would begin between 2001 and 2003 and would be completed between 2007 and 2009. Employment for the operation of the facility would begin in the year 2007 and reach full employment by 2010. Locating any of the tritium supply technologies at NTS would create new jobs at the site and indirectly create other jobs in the region. However, this job creation and the additional economic effects would be less than the effects that would occur with the collocation of the tritium supply technologies with the recycling facilities.

Construction. Construction of the tritium supply technologies only would require between 3,400 and 12,600 worker-years of activity over a 5- to 9-year period. New jobs would be created, but this employment growth would be much less than 1 percent over No Action estimates. Appendix table D.3–23 presents the estimates of total employment during peak construction in 2005 resulting from the tritium supply technologies. The total jobs (direct and indirect) that would be created can be calculated by subtracting the tritium recycling contribution from




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution.
Note: Under No Action per capita income is projected to be $22,780 in 2005 and $23,640 in 2010.
Source: Appendix table D.3–24.

**FIGURE 4.3.3.8–2.—*Unemployment Rate, Per Capita Income, and Percentage Increase over No Action from Tritium Supply Technologies and Recycling for Nevada Test Site Economic Study Area.***

the tritium supply technologies and recycling in figure 4.3.3.8–1.

Although the construction of the facility would create new jobs, the effects would not be enough to greatly affect the unemployment rate projected for No Action. Additionally, per capita income in the region would rise only slightly above that estimated for No Action. Estimates of unemployment rate and per capita income for the tritium supply technologies are presented in appendix table D.3–23 or can be derived by subtracting tritium recycling contributions from the values for the tritium supply technologies and recycling figure 4.3.3.8–2.

Operation. Operation employment for the tritium supply technologies only would begin phasing in at the end of the construction period, and be at full employment in the year 2010. Full employment is expected to be maintained for the life of the facility. Estimates for full employment in 2010 are presented in appendix table D.3–23. Total project related jobs created by the tritium supply technologies alone can be calculated by subtracting the tritium recycling contribution in figure 4.3.3.8–1.

The addition of new jobs during operation would reduce the unemployment rate below the projection for No Action. The unemployment rate for 2010, the first year of full operation employment, is presented in appendix table D.3–23 or can be derived by subtracting tritium recycling contribution in figure 4.3.3.8–2. Unemployment would be reduced from the No Action projection of 5 percent to a range of 4.6 to 4.7 percent during the years 2010 and 2020 depending on the technology selected.

The creation of new jobs as a result of the tritium supply operation would also increase income slightly over the No Action estimates. Appendix table D.3–23 presents the per capita income for the tritium extraction and recycling facility for the year 2010. Per capita income growth can also be calculated by subtracting tritium recycling contribution in figure 4.3.3.8–2. During the years 2010 and 2020, per capita income annual increases would be 1 percent, the same annual increase projected under No Action.

*Less Than Baseline Operations.* Tritium supply technologies that provide less than the baseline tritium capacities are described in section 3.1. These options may or may not be collocated with the tritium recycling facilities. The options include lowering the power in the HWR, using fewer target rods in the MHTGR and ALWR, and the phased approach for the APT.

Construction. The less than baseline operation case for the HWR, MHTGR, and ALWR would have the same construction workforce requirements as discussed in the tritium supply and recycling and tritium supply only sections. Therefore, employment and economic effects in the region would be the same.

The Phased APT would require the same total number of construction workers as the Full APT, but the construction period would span the years 1999 to 2008 instead of 2003 to 2007. Additionally, peak construction would occur in 2003 instead of 2005. The effects on the economic study area's employment, unemployment rate, and per capita income as a result of constructing the Phased APT are presented in appendix table D.3–23. Appendix table D.3–24 presents the effects on employment, unemployment rate, and per capita income for constructing the Phased APT with tritium recycling facilities. Generally, average annual increases in employment and income are similar to those for the Full APT, but these increases are over a longer period of time. These increases are between 1 percent and 2 percent, the same as the No Action estimates.

Operation. Operation workforce requirements for the less than baseline tritium requirement case for the HWR, MHTGR, ALWR, and the Phased APT would be the same as those described in the tritium supply and recycling and tritium supply only sections. Thus, regional employment and economic effects would be the same.

**Population and Housing.** Changes to ROI population and housing expected from the proposed action at NTS are described in this section. Additional population could be expected to in-migrate to the NTS region and these people would be expected to reside in cities and counties within the ROI in the same relative proportion as the existing population. Increases to the population could lead to a demand for additional housing units beyond existing vacant housing available during construction or operation phases of the proposed action. Figures 4.3.3.8–3 and

4.3.3.8–4 present the changes in population and housing over No Action with the tritium supply technologies and recycling facilities.

*No Action.* Under No Action, population and housing increases between 2001 and 2009 are projected to be 1 percent. Future annual average increases are also projected to be 1 percent between 2010 and 2020. Population in the ROI is estimated to reach 1,020,900 in 2010 and 1,103,500 in 2020. Total housing units in the ROI are estimated to reach 437,400 in 2010 and 472,800 in 2020. No Action estimates are presented in appendix tables D.3–25 and D.3–28.

*Tritium Supply and Recycling.* It is expected that the proposed action at NTS would increase population and housing demands in the ROI slightly (2 percent) over No Action projections during peak construction. The effects are expected to be fewer (much less than 1 percent) during the operation phase of the proposed action.

Construction. Construction activities would be phased over a 5- to 9-year period. Figure 4.3.3.8–3 illustrates that during peak construction (year 2005), the ALWR would create the largest population and housing demand increases over No Action, and the APT would have the fewest effects. The increase in population could require some additional housing units beyond what is currently available in the existing housing mix. However, any requirements for additional housing units would be at annual average increases of 2 percent in the first 3 years of construction of the ALWR, followed by an approximately 1-percent increase until peak operation. The other tritium supply technologies would have annual average population and housing demand growth of less than 2 percent. Therefore, there would not be any major effects on any of the ROI communities.

Operation. Operation of any of the tritium supply technologies and recycling facilities is expected to reach full employment by 2010. In-migrating population is expected to require housing units similar to the existing housing mix in the ROI. Figure 4.3.3.8–4 shows that population increases and potential demand for additional housing units over No Action projections are almost negligible (less than 1 percent) in this peak year. Given that the operation of the proposed action would be phased in over a 4-year period, it is expected that existing vacancies would absorb much of this new demand and that No Action requirements would be exceeded by very few units.

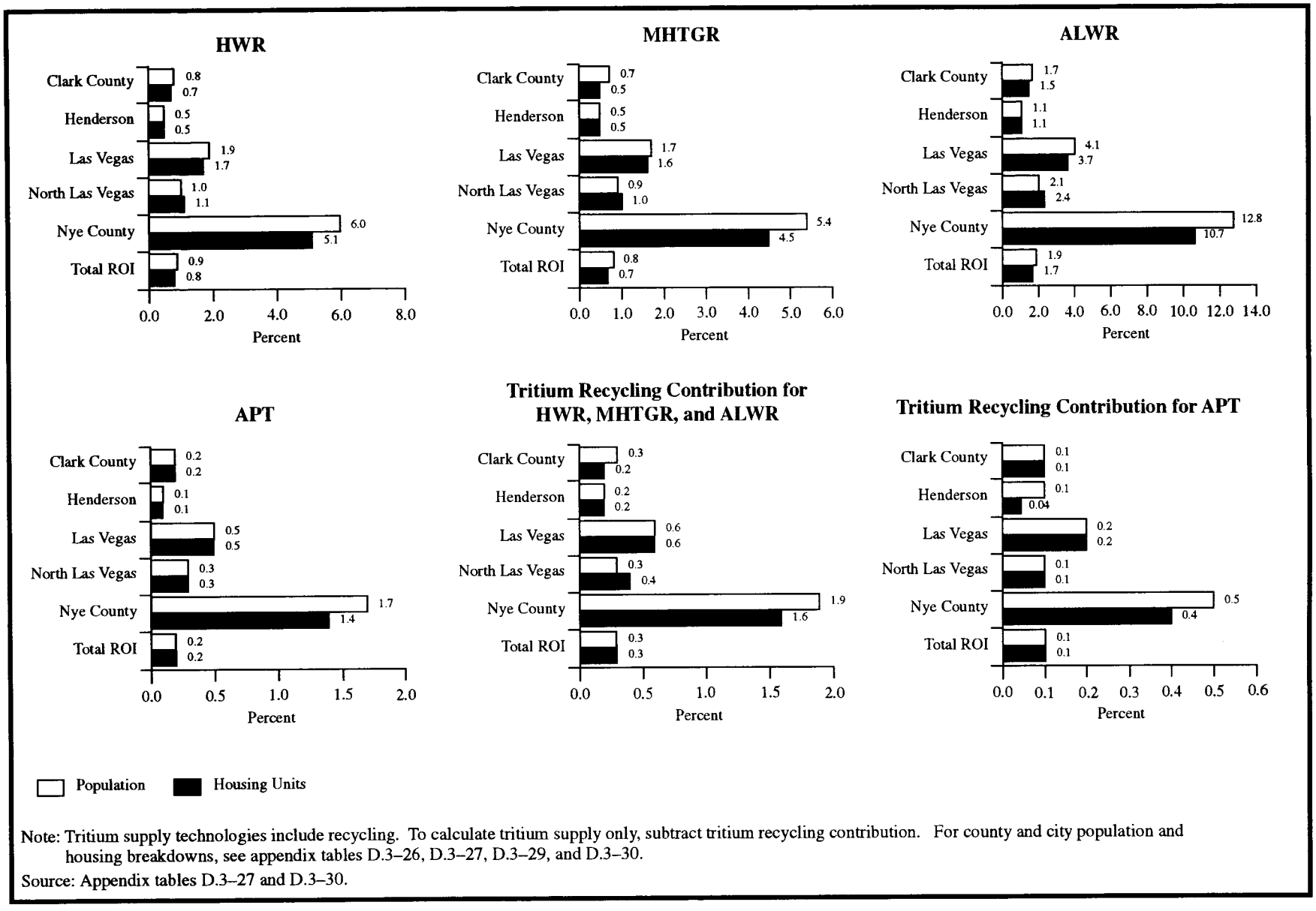
*Tritium Supply Alone.* Locating only a tritium supply technology at NTS would not increase population or housing demands in the ROI more than 2 percent over No Action projections during the construction period or 1 percent during operation.

Construction. Construction activities for the tritium supply technologies alone would be lower than if collocated with the tritium recycling facilities. The greatest increase in population and housing demand would occur during peak construction in 2005. Appendix tables D.3–26 and D.3–29 show that available vacancies in the existing housing mix would probably accommodate the expected population growth. Estimated growth in the ROI is less than 1 percent over the No Action projection.

Operation. Full employment levels for any of the tritium supply technologies alone would be reached by the year 2010. In-migrating population would be expected to require housing units similar to the existing mix in the ROI. These requirements would be lower than those any of the tritium supply technologies with the recycling facilities. Potential demand for housing units would be less than 1 percent in the first year of full employment as illustrated in appendix tables D.3–26 and D.3–29. It is expected that existing vacancies would absorb most of this new demand as employment would be phased in during the years 2007 through 2010.

*Less Than Baseline Operations.* Population increases and housing demands would be the same or lower during construction and operation of tritium supply technologies operated at less than baseline tritium requirements than the alternatives discussed in the tritium supply and recycling and tritium supply only sections.

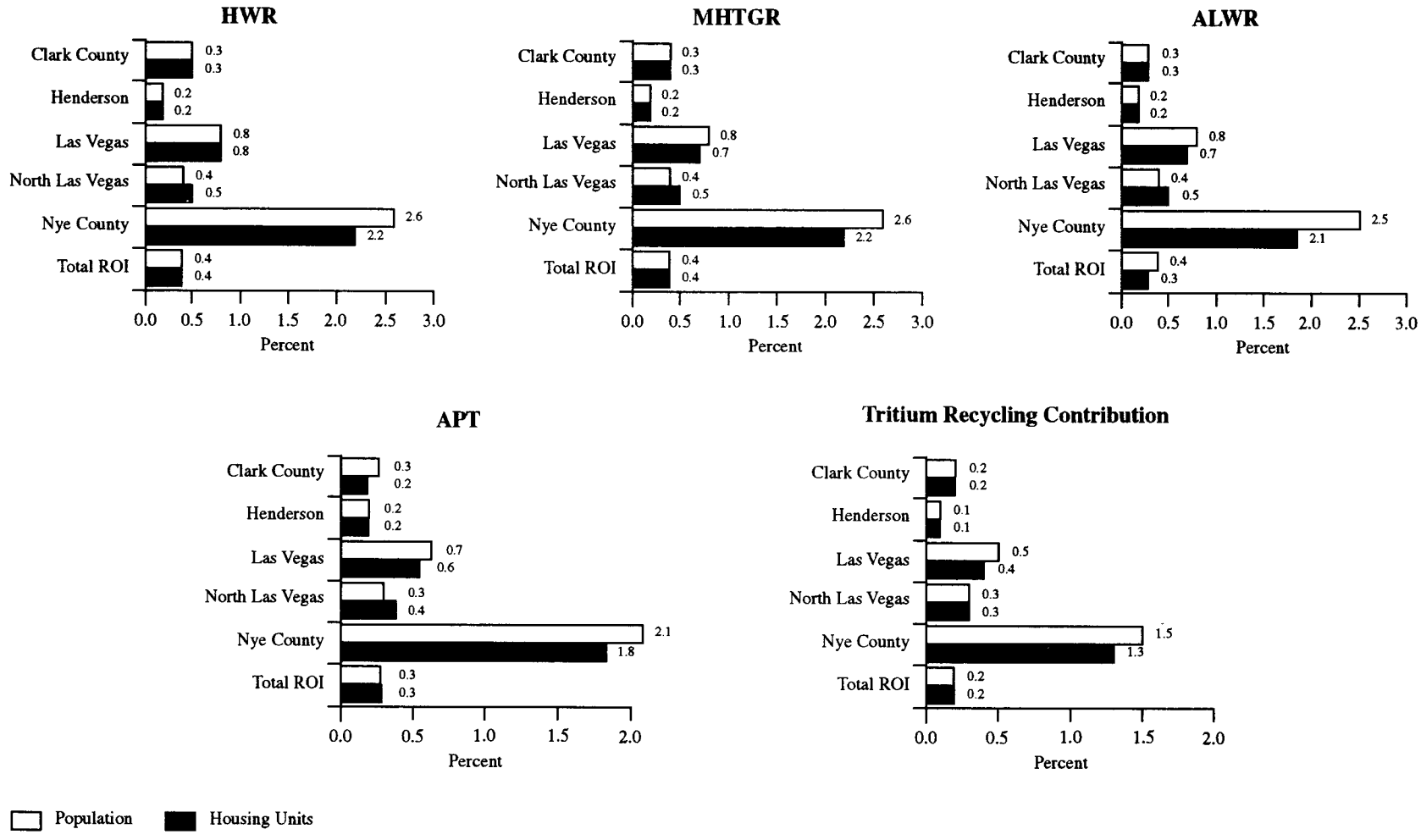
Construction. Population increases and housing demands would be the same as those given in figure 4.3.3.8–3 for the HWR, MHTGR, and ALWR. The Phased APT would increase population and housing demand during construction to the same level as the Full APT, but this would occur over a longer construction period with lower average annual increases. Also, the peak construction year would be 2003




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–26, D.3–27, D.3–29, and D.3–30.

Source: Appendix tables D.3–27 and D.3–30.

**FIGURE 4.3.3.8–3.—*Total Population and Housing Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–26, D.3–27, D.3–29, and D.3–30.

Source: Appendix tables D.3–27 and D.3–30.

**FIGURE 4.3.3.8–4.**—***Total Population and Housing Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence, 2010.***

instead of 2005. The effects of the Phased APT on population and housing are presented in appendix tables D.3–26 and D.3–29, respectively. Appendix tables D.3–27 and D.3–30 present the results of constructing the Phased APT with the tritium recycling facilities.

Operation. The effects on population and housing of operating the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirements would be the same as those presented in figure 4.3.3.8–4.

**Public Finance.** Fiscal changes could occur in some ROI local jurisdictions from the proposed action. Factors influencing these changes include residence of project-related employees and their dependents, cost and duration of construction, and economic conditions in the ROI once the new facilities are operational.

Adding the tritium supply technologies and recycling facilities to NTS would increase population, resulting in more revenues for ROI local jurisdictions. Additional population would also increase public service expenditures. Figures 4.3.3.8–5 and 4.3.3.8–6 present the potential fiscal changes that would occur with the different tritium supply technologies and recycling facilities.

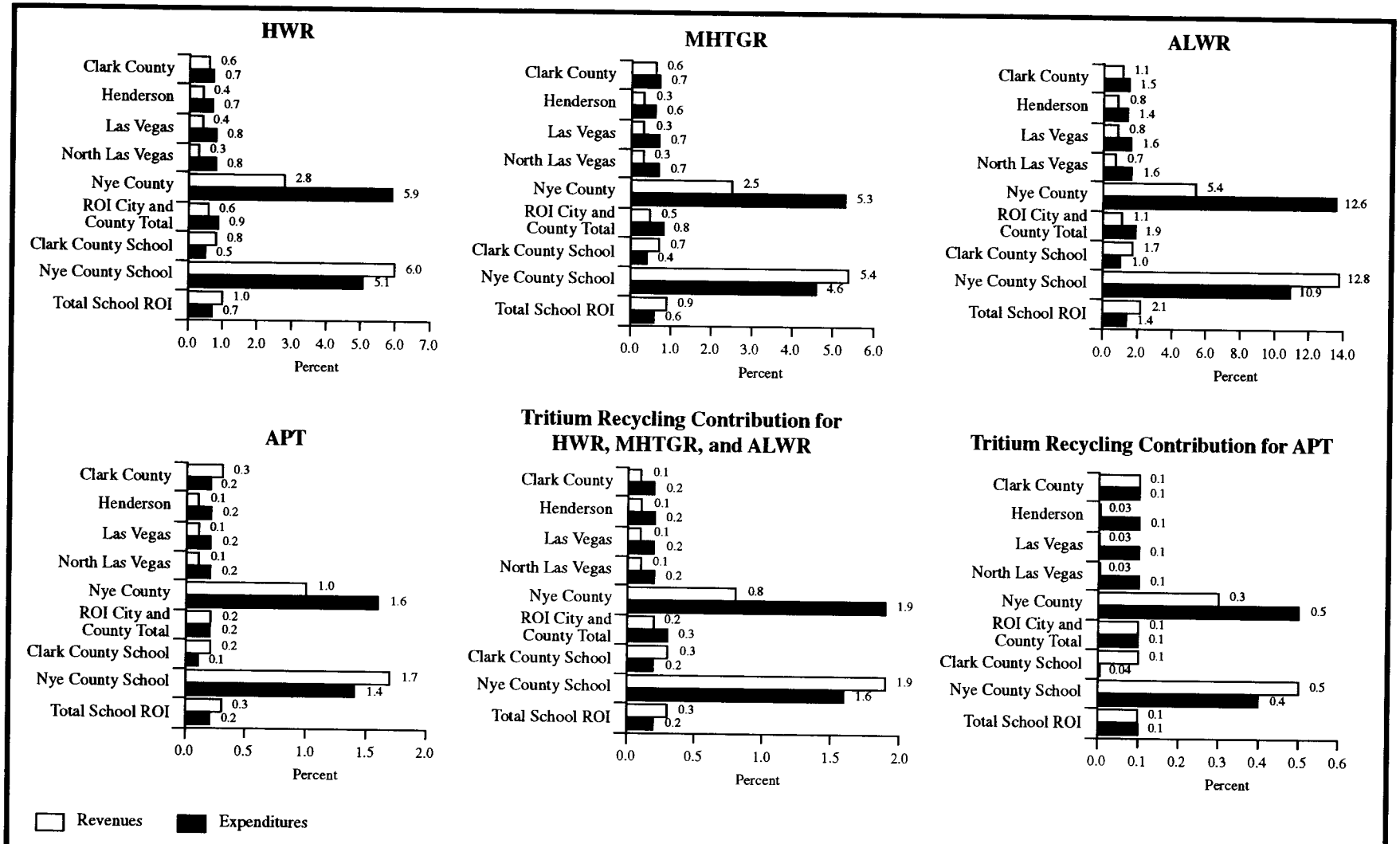
*No Action.* Appendix tables D.3–31 and D.3–32 present the 1992 public finance characteristics for local ROI jurisdictions. Appendix tables D.3–33 through D.3–36 present the impacts from tritium supply technologies alone or collocated with recycling facilities compared to No Action during construction and operation for the local ROI counties, cities, and school districts. Between 2001 and 2005, all ROI counties, cities, and school districts are projected to increase total revenues on an annual average of less than 1 to 5 percent. Total expenditures are also projected to increase on an annual average of 1 to 5 percent for all ROI counties, cities, and school districts between 2001 and 2005. Between 2005 and 2010, total revenues and expenditures are expected to increase from 1 to 2 percent for all counties, cities, and school districts in the ROI.

Between 2010 and 2020, projected annual average increases in total revenues are less than 1 percent for all counties, cities, and school districts in the ROI. Total expenditures are also projected to increase on an average by 1 percent or less for ROI jurisdictions between 2010 and 2020.

*Tritium Supply and Recycling.* The proposed action at NTS would create some fiscal benefits to local jurisdictions within the ROI. Some local government finances would be affected during the construction and operation phases of the proposed action. Construction-related effects on revenues and expenditures could span a period of 5 to 9 years with the peak occurring in 2005. The effects of the operation phase would peak in 2010 and remain at this level throughout the life of the facilities.

Construction. The public finances of counties, cities, and school districts within the ROI would be affected by the construction-related activities associated with the proposed action. Initially, there would be slight increases to some local government jurisdictions' revenues and expenditures, which would peak in the year 2005 and then decline as construction neared completion. Figure 4.3.3.8–5 presents the revenue and expenditure changes of ROI local government jurisdictions over No Action during peak construction for the four tritium supply technologies and recycling facilities. Over the construction phase of the proposed action, revenues and expenditures would increase slightly over No Action at an annual average of less than 1 to 4 percent. Under the tritium supply with recycling, revenues and expenditures would increase between 1 percent and 4 percent in the first three years of construction. After the peak construction year, there would be increases of 1 to 2 percent annually until 2010 for most local jurisdictions.

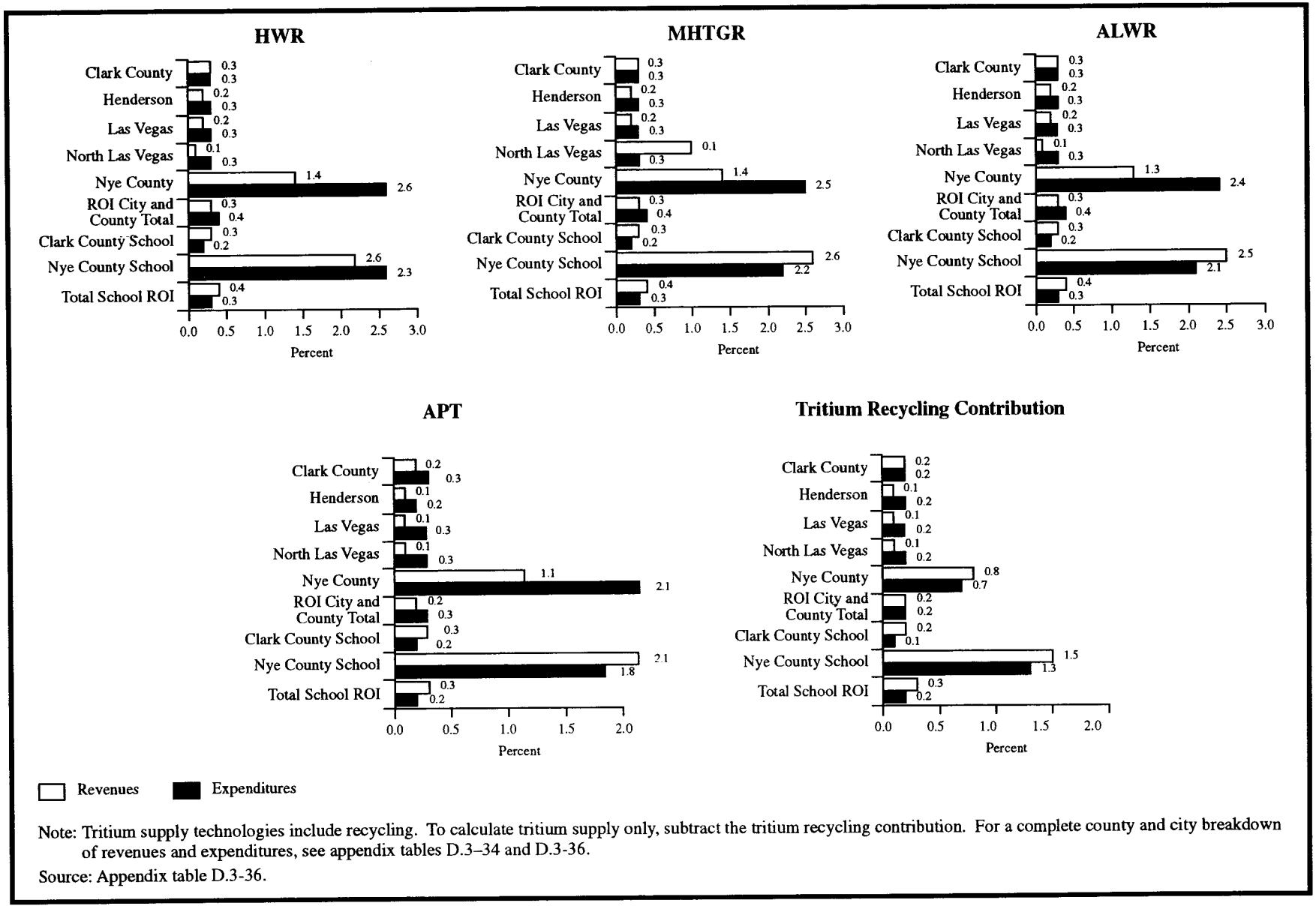
Operation. The effects of phasing in operation together with the phasing out of construction on ROI local government finances would be fewer than the effects at peak or full operation (year 2010). The effects that the four tritium supply technologies and recycling facilities would have on county, city, and school district revenues and expenditures are presented in figure 4.3.3.8–6. Between 2010 and 2020, revenues are expected to increase at an average annual rate of 1 percent or less for most jurisdictions. Expenditures are expected to increase to the year 2020 at an annual average of 1 percent. No Action local government revenues and expenditures would also increase at an average annual rate of 1 percent.




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract the tritium recycling contribution. For a complete county and city breakdown of revenues and expenditures, see appendix tables D.3–33 and D.3-35.

Source: Appendix table D.3-35.

**FIGURE 4.3.3.8–5.—*County, City, and School District Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract the tritium recycling contribution. For a complete county and city breakdown of revenues and expenditures, see appendix tables D.3–34 and D.3-36.

Source: Appendix table D.3-36.

**FIGURE 4.3.3.8–6.—*County, City, and School District Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence, 2010.***

*Tritium Supply Alone.* Locating the tritium supply without the recycling facilities at NTS would create some fiscal benefits to local jurisdictions within the ROI, but these effects would be less than the effect of collocation with tritium recycling.

Construction. Construction-related effects from the tritium technologies alone on the revenues and expenditures of counties, cities, and school districts would be similar but less than the effects from the tritium supply technologies with recycling facilities. Appendix table D.3–33 presents the revenue and expenditure changes of ROI local governments over No Action during peak construction of the tritium supply technology only.

Operation. The operation phase of the tritium supply technology only would affect the public finances of counties, cities, and school districts in the ROI but these effects would be less than the tritium supply technologies with the recycling facilities. Appendix table D.3–34 presents the effects that operation would have on these local jurisdictions in the year 2010. During the years 2010 to 2020, revenues and expenditures are expected to increase less than 1 percent. In comparison, No Action local government revenues and expenditures would increase at an average annual rate of 1 percent.

*Less Than Baseline Operations.* The fiscal benefits that local jurisdictions would accrue from the location of a tritium supply technology alone or collocated with recycling would be the same or less if the tritium supply technologies were operated at less than baseline tritium requirements.

Construction. Increases in local jurisdictions' revenues and expenditures would be the same as those given in figure 4.3.3.8–5 if the HWR, ALWR, or MHTGR are built. If the Phased APT is constructed, the effects would peak in the year 2003 instead of 2005, and the annual average increases would be lower. Appendix tables D.3–33 and D.3–34 present the revenue and expenditure changes as a result of constructing the Phased APT for all ROI jurisdictions. Revenue and expenditure changes resulting from the construction of the Phased APT with tritium recycling are presented in appendix tables D.3–35 and D.3–36.

Operation. Operation of the HWR, MHTGR, ALWR and Phased APT at less than baseline would have the same effects on local jurisdictions' finances as those presented in figure 4.3.3.8–6.

**Potential Mitigation Measures.** Adding new missions to NTS would create new jobs and generally benefit the local economy through increased earnings in the ROI. Some mitigation measures may be required, such as Federal aid to local school districts where additional school age children would attend as a result of siting the tritium facilities at NTS. These new missions at NTS would increase population and the demand for additional housing units. Temporary housing units and mobile homes would help to alleviate the demand for new housing during the construction phase of the proposed action. Generally, construction would be phased over a period of 5 to 9 years with peak construction occurring in the year 2005. Phasing the start of operation employment and training between 2005 and 2010 would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

**Local Transportation.** The following is a description of the effects on local transportation resulting from constructing and operating tritium supply and recycling facilities at NTS. Construction and operation of a tritium supply technology with the recycling facilities are expected to increase traffic flow rates on site access routes.

*No Action.* Under No Action, the worker population at NTS would not increase. Therefore, any increases in traffic would not be the result of DOE-related activities at NTS. Segments providing access to NTS include U.S. Route 95, State Routes 160 and 373. Traffic conditions on site access roads would remain as described in section 4.3.2.8.

*Tritium Supply and Recycling.* The proposed action at NTS would result in increases, depending on the tritium supply technology, of worker population at the site. Traffic volume on site access roads leading to and from NTS would increase due to the additional workforce. The primary access route to NTS is U.S. Route 95. This route would carry the greatest increase in traffic volume from site development. Locating the MHTGR or ALWR at NTS would have the greatest effect on traffic volume and flow.

*Tritium Supply Alone.* Locating a tritium supply technology without the recycling facility at NTS would result in increased worker population, thereby increasing traffic on site access roads. However, the effects on traffic would be fewer than siting the tritium recycling facility with any one of the tritium supply technologies.

*Less Than Baseline Operations.* The effects on traffic volume and flow will be the same whether or not the HWR, MHTGR or ALWR operated at baseline or less than baseline tritium requirements. Construction of the Phased APT would increase traffic volume flow during the construction phase but less than the Full APT.

*Potential Mitigation Measures.* Mitigation of traffic conditions may be necessary due to the proposed action at NTS. Potential mitigation of impacts to the local transportation network could include widening and extending U.S. Route 95, as well as possible realignment of roadways and construction of interchanges at roadway intersections overburdened by increased vehicle traffic and congestion.

#### 4.3.3.9 *Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents*

This section describes the impacts of radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or accidents associated with tritium supply technologies and recycling facilities at NTS. The section first describes the impacts from normal operation, followed by a description of impacts from facility accidents.

During normal operation at NTS, all tritium supply technologies and recycling facilities would result in impacts that are within regulatory limits. The risk of adverse health effects to the public and to workers would be small.

For facility accident impacts, the results indicate that for all technologies, the risk of fatal cancers (taking into account both the probability of the accident and its consequences) from an accidental release of radioactive or hazardous chemical substances at NTS is low when compared to fatal cancers from all causes, including severe accidents.

The impact assessment methodology is described in section 4.1.9. Summaries of the radiological and chemical impacts associated with normal operation are presented in tables 4.3.3.9–1 and 4.3.3.9–2, respectively. Summaries of impacts associated with postulated accidents are given in tables 4.3.3.9–3 and 4.3.3.9–4. Detailed results are presented in appendix E for normal operation and in appendix F for accidents.

**Normal Operation.**

*No Action.* The current missions at NTS are described in section 3.3.2. The site has identified those facilities that will continue to operate and others which will become operational by 2010. Based on that information, the radiological releases for 2010 and beyond were developed and used in the impact assessments.

Radiological Impacts. As shown in table 4.3.3.9–1, No Action would result in a calculated annual dose of 0.040 mrem to the maximally exposed member of the public, which projects to an estimated fatal cancer risk of $8.1 \times 10^{-7}$ from 40 years of total site operation. This annual dose is within radiological limits and is 0.013 percent of the natural background radiation received by the average person near NTS.

The population dose from total site operation in the year 2030 was calculated to be $8.2 \times 10^{-3}$ person-rem, which projects to an estimated $1.6 \times 10^{-4}$ fatal cancers from 40 years of total site operation. The population dose in year 2030 would be approximately $1.4 \times 10^{-4}$ percent of the dose received by the surrounding population from natural background radiation.

The annual average dose to a site worker resulting from No Action would be 5 mrem, which projects to an estimated fatal cancer risk of $7.8 \times 10^{-5}$ from 40 years of site operation. The annual dose to the total site workforce would be 3 person-rem, which projects to an estimated 0.048 fatal cancers from 40 years of total site operation. These estimates are based on the annual average worker doses at NTS from 1989 to 1992, and projected employment levels in 2010.

Hazardous Chemical Impacts. There are no hazardous chemical emissions resulting from No

**TABLE 4.3.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Nevada Test Site***

| Affected Environment | No Action | Tritium Supply Technologies and Recycling | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | HWR[a] | MHTGR[a] | ALWR[a] | | APT[a] | | | Tritium Recycling |
| | | | | Large | Small | Full | | Phased | |
| | | | | | | Helium-3 Target System | SILC Target System | Helium-3 Target System | |
| **Maximally Exposed Individual (Public)[b]** | | | | | | | | | |
| Dose (mrem per year)[c] | 0.040 | 0.31 | 0.21 | 0.40 | 0.40 | 0.13 | 0.18 | 0.13 | 0.12 |
| Percent of natural background[d] | 0.013 | 0.098 | 0.065 | 0.13 | 0.13 | 0.040 | 0.057 | 0.040 | 0.038 |
| 40-year fatal cancer risk | $8.1 \times 10^{-7}$ | $6.2 \times 10^{-6}$ | $4.1 \times 10^{-6}$ | $8.0 \times 10^{-6}$ | $8.0 \times 10^{-6}$ | $2.6 \times 10^{-6}$ | $3.6 \times 10^{-6}$ | $2.6 \times 10^{-6}$ | $2.4 \times 10^{-6}$ |
| **Population Within 50 Miles** | | | | | | | | | |
| ***Year 2030*** | | | | | | | | | |
| Dose (person-rem) | $8.2 \times 10^{-3}$ | 0.20 | 0.13 | 0.24 | 0.25 | 0.080 | 0.11 | 0.080 | 0.070 |
| Percent of natural background[d] | $1.4 \times 10^{-4}$ | $3.4 \times 10^{-3}$ | $2.2 \times 10^{-3}$ | $4.2 \times 10^{-3}$ | $4.3 \times 10^{-3}$ | $1.4 \times 10^{-3}$ | $1.9 \times 10^{-3}$ | $1.4 \times 10^{-3}$ | $1.2 \times 10^{-3}$ |
| 40-year fatal cancers | $1.6 \times 10^{-4}$ | $4.0 \times 10^{-3}$ | $2.6 \times 10^{-3}$ | $4.9 \times 10^{-3}$ | $5.1 \times 10^{-3}$ | $1.6 \times 10^{-3}$ | $2.3 \times 10^{-3}$ | $1.6 \times 10^{-3}$ | $1.4 \times 10^{-3}$ |
| **Worker Onsite** | | | | | | | | | |
| Average worker dose (mrem per year)[c] | 5 | 34 | 26 | 140 | 92 | 43 | 44 | 43 | 4 |
| 40-year fatal cancer risk | $7.8 \times 10^{-5}$ | $5.4 \times 10^{-4}$ | $4.2 \times 10^{-4}$ | $2.3 \times 10^{-3}$ | $1.5 \times 10^{-3}$ | $6.9 \times 10^{-4}$ | $7.0 \times 10^{-4}$ | $6.9 \times 10^{-4}$ | $6.4 \times 10^{-5}$ |
| Total workforce dose (person-rem per year) | 3 | 44 | 33 | 180 | 100 | 56 | 57 | 56 | 1.6 |
| 40-year fatal cancers | 0.048 | 0.70 | 0.53 | 2.8 | 1.7 | 0.90 | 0.91 | 0.90 | 0.026 |

[a] Includes impacts from No Action facilities.

[b] The location of the maximally exposed individual varies depending on the tritium supply technology.

[c] The applicable radiological limits to an individual member of the public from site operations are 10 mrem per year resulting from the air pathways and 100 mrem per year from all pathways combined (DOE Order 5400.5). The radiological limit for an individual worker is 5,000 mrem per year (40 CFR 835)

[d] Natural background level to the average individuals is 317 mrem; to the population in the year 2030 is 5,860 person-rem.

Note: SILC - spallation-induced lithium conversion.

Note: Model results. See appendix sections E.2.2, E.2.5, and E.2.5.2.

Action at NTS; therefore, acceptable regulatory health limits are met.

*Tritium Supply and Recycling.*

There will be no radiological releases during the construction of new tritium recycling facilities that are associated with all tritium supply technologies under consideration. However, limited hazardous chemical releases are anticipated as a result of construction activities. The concentration of releases will be well within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The impacts from radiological and hazardous chemicals from each tritium supply technology considered are the summations of the impacts from the various facilities in operation for that technology. The resulting doses and potential health effects to the public and workers from each tritium supply technology are described below.

Radiological Impacts. Radiological impacts to the public resulting from normal operation from the tritium supply technology and recycling facilities considered for NTS are listed in table 4.3.3.9–1. The supporting analysis is provided in appendix section E.2.5.2.

The doses to the maximally exposed member of the public from annual operation at NTS range from 0.13 mrem for both the APT with the helium-3 target option and the Phased APT to 0.40 mrem for both the Large and Small ALWR. From 40 years of operation, the corresponding risks of fatal cancer to this individual would range from $2.6 \times 10^{-6}$ to $8.0 \times 10^{-6}$. As a result of total site operation in the year 2030, the population doses would range from 0.080 person-rem for the same two APT technologies, to 0.25 person-rem for the Small ALWR. The corresponding numbers of fatal cancers in this population from 40 years of operation would range from $1.6 \times 10^{-3}$ to $5.1 \times 10^{-3}$.

The annual dose to the total site workforce would range from 33 person-rem for the MHTGR to 180 person-rem for the Large ALWR. The annual average dose to a site worker would range from 26 to 140 mrem for the same two technologies, respectively. The risks and numbers of fatal cancers among workers from 40 years of operation are included in table 4.3.3.9–1

Based on the radiological impacts associated with normal operation as described above, all of the tritium supply technologies and recycling facilities are acceptable for siting at NTS. All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. As shown in table 4.3.3.9–2, the HIs to the maximally exposed individual of the public resulting from hazardous chemical emissions at NTS range from $1.8 \times 10^{-7}$ for the APT to $7.7 \times 10^{-5}$ for the ALWR, whereas a cancer risk of 0 was calculated for all tritium supply technologies. The worker HIs ranged from 0.038 for the ALWR to $3.4 \times 10^{-5}$ for the APT. There was no cancer risk was for any of the tritium supply technologies. All values are within the acceptable regulatory health limits. For details on the derivation of these HIs and cancer risks, see appendix tables E.3.4-9 through E.3.4-12 and summary table E.3.4-14.

*Tritium Supply Alone.*

Radiological Impacts. If the tritium recycling processes were not collocated with the tritium supply, the annual dose to the maximally exposed individual would decrease by 0.12 mrem, which is 0.038 percent of the dose from natural background radiation received by the average person near NTS. The estimated risk of fatal cancer to this individual would decrease by $2.4 \times 10^{-6}$ over 40 years of total site operation.

Not collocating the tritium recycling processes at NTS would result in a decrease of 0.07 person-rem to the population within 50 miles in year 2030, and $1.4 \times 10^{-3}$ fewer fatal cancers over 40 years of operation.

If the tritium recycling processes were not collocated with the tritium supply, the average annual dose to an onsite worker would decrease by 4 mrem per year. In addition, the estimated risk of fatal cancer to this worker would decrease by $6.4 \times 10^{-5}$ over 40 years of site operation. The total annual workforce dose would decrease by 1.6 person-rem, resulting in 0.026 fewer fatal cancers over the 40 years.

**TABLE 4.3.3.9–2.—*Potential Hazardous Chemical Impacts to the Public and Workers Resulting from Normal Operation at Nevada Test Site***

| Health Impact | No Action | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR[a, b] | MHTGR[a, b] | ALWR[a, b] | APT[a, b] | Tritium Recycling |
| **Maximally Exposed Individual (Public)** | | | | | | |
| Hazard Index | 0 | $6.3 \times 10^{-6}$ | $2.2 \times 10^{-7}$ | $7.7 \times 10^{-5}$ | $1.8 \times 10^{-7}$ | $9.1 \times 10^{-8}$ |
| Cancer risk | 0 | 0 | 0 | 0 | 0 | 0 |
| **Worker Onsite[c]** | | | | | | |
| Hazard Index | 0 | $3.2 \times 10^{-3}$ | $3.4 \times 10^{-5}$ | 0.038 | $3.4 \times 10^{-5}$ | $1.7 \times 10^{-5}$ |
| Cancer risk | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Includes impacts from No Action.

[b] To determine the contribution from any of the tritium supply technologies, subtract the tritium recycling values fro the Hazard Index or from the cancer risk, respectively.

[c] The Hazard Index for the onsite worker is computed by using the permissible exposure level as the denominator rather than the reference concentration which is used for the maximally exposed member of the public (appendix E).

Note: Model results. See appendix table E.3.4–14.

Hazardous Chemical Impacts. If the tritium recycling processes are eliminated from all of the supply technologies at NTS, the cancer risks would not change since there is no cancer risk resulting from any options. The effect on HIs for the public however, could be reduced as much as 41 to 51 percent (MHTGR and APT) or as little as 1.4 to 0.1 percent (HWR and ALWR); the corresponding effect on HIs for workers would be a reduction of 5 percent for MHTGR or APT and 0.5 percent and 0.04 percent for HWR and ALWR, respectively. Based on the hazardous chemical impacts associated with normal operations at NTS, all values are within regulatory health limits.

*Less Than Baseline Operations.* The normal operation radiological impacts for the HWR operating at the reduced tritium production capacity to meet a less than baseline tritium operation requirement would be proportional to the level of operation (approximately 50 percent of baseline). The MHTGR or ALWR normal operation radiological impacts would not change because the reactor would maintain power requirements to produce steam or electricity.

The Phased APT is already less than the baseline tritium requirement and thus the impacts are presently given in this PEIS.

*Potential Mitigation Measures.* Radioactive and hazardous chemical airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated and robotic production methods are examples of techniques that are being developed which could reduce worker exposure. Substitution of less toxic/noncancer causing solvents would result in reductions of the HI and possible complete elimination of the cancer risk.

**Facility Accidents.**

*No Action.* Under No Action, the risk of accidents at NTS would be unchanged from that reported in plant safety documentation for existing facilities since no additional activities would be undertaken.

*Tritium Supply and Recycling.* The proposed action at NTS has the potential for accidents that may impact the health and safety of workers and the public. This potential for and associated consequences of reasonably foreseeable accidents have been assessed for each tritium supply technology and recycling facilities at NTS and are summarized in this section and described in more detail in appendix F.

The methodology used in the assessment is described in section 4.1.9.

The potential impacts from accidents, ranging from high-consequence/low-probability to low-consequence/high-probability events, have been evaluated in terms of the number of cancer fatalities that may result. The risk of cancer fatalities has also been evaluated to provide an overall measure of an accident's impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities).

Analyses of postulated accidents for the tritium supply technology and recycling facilities at NTS indicate that, for the high consequence accident, the estimated risk of cancer fatalities to the public within 50 miles of the site is $5.7 \times 10^{-7}$ cancer fatalities per year (table 4.3.3.9–3). This accident risk, which corresponds with the ALWR, is low when compared to the risk of cancer fatalities each year to the same population from all causes.

Details on the range of accidents for the tritium supply technologies and recycling facilities at NTS are presented in appendix F. Each of the technologies has been analyzed from the standpoint of identifying the consequences of design basis/operational accidents (using the GENII Code) and beyond design basis, or severe accidents (using the MACCS computer code). The severe accident consequences are shown in table 4.3.3.9–3 for each technology. The table also shows the consequences of each accident for the population within 50 miles of the site and for an individual who may be located at the site boundary. The results of the analysis indicate that the ALWR has the highest severe accident consequence. The technology with the lowest accident consequence is the APT with the helium-3 target system. The results take into account accidents that may occur in the tritium supply system as well as the tritium recycling and other support facilities. The tritium recycling facility is common to all tritium supply technologies but, except for the APT, the consequences are dominated by reactor accidents. The APT accident consequences are lower than the tritium extraction facility's accident consequences.

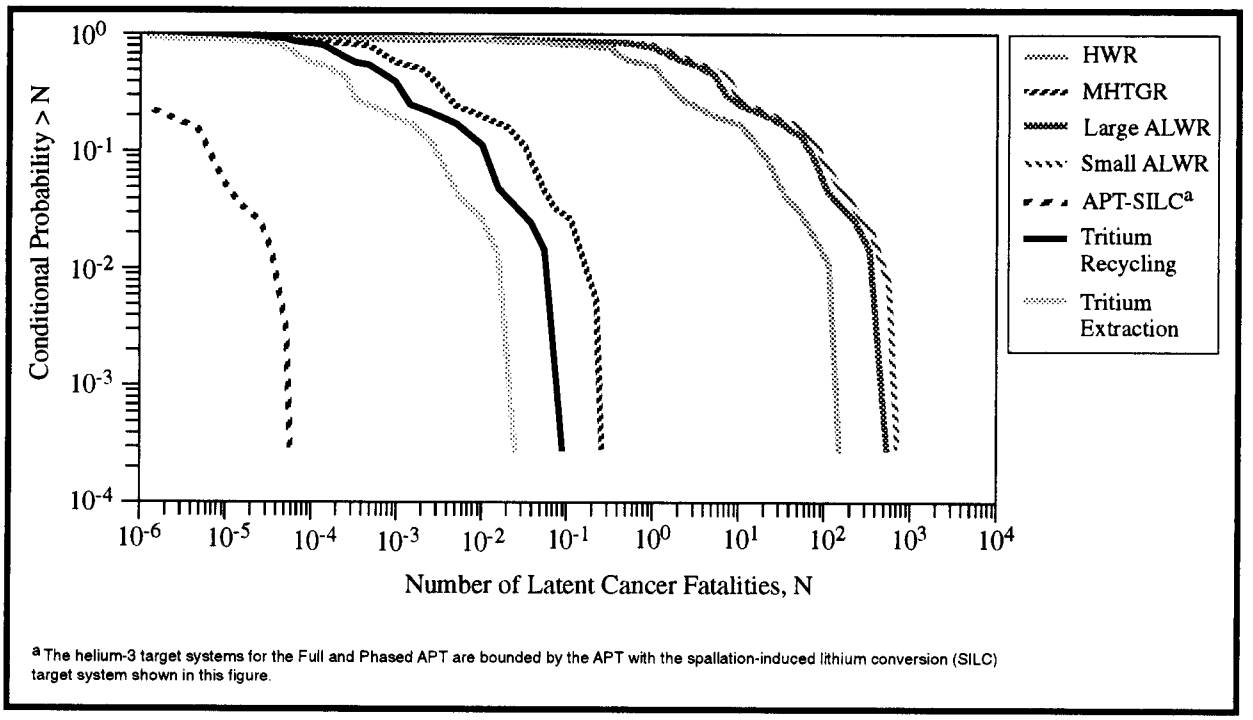
Figure 4.3.3.9–1 shows the number of latent cancer fatalities that may result for each technology, including tritium extraction and recycling, if a high consequence accident were to occur. Specifically, each curve in the figure shows the conditional probability (vertical axis) that the number of cancer fatalities (horizontal axis) will be exceeded if the accident occurred. The curves to do not reflect the probability of the accident.

The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may be destroyed; the supply of drinking water may be reduced; recreational areas may be closed; industrial parks may suffer economic losses; historical sites may have to be closed to visitors; and endangered species may move closer to extinction. In the region of the NTS, the natural background level of radiation (excluding radon) is 78 mrem per year. For a hypothetical design basis accidental release, the radiation levels exceeding 78 mrem per year are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $9.1 \times 10^{5}$ square meters (225 acres).

*Tritium Supply Alone.* The analyses of reasonably foreseeable high consequence accidents for the tritium supply facilities at NTS are presented below.

Heavy Water Reactor. A set of accident sequences with a release category in which there is a reactor isolation failure with containment spray failed was postulated as a high consequence accident for the HWR. In the event that this accident were to occur, there would be an estimated 6.4 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.8 \times 10^{-3}$ to an individual located at the site boundary during the accident. The risk to the population, taking the probability of the accident into account, is $3.2 \times 10^{-7}$ cancer fatalities per year (table 4.3.3.9–3).

Modular High Temperature Gas-Cooled Reactor. A set of accident sequences with a release category in which there is a depressurized conduction cooldown without the reactor cavity cooling system functioning. This would be a high consequence accident for the MHTGR. In the event that this accident were to




[a] The helium-3 target systems for the Full and Phased APT are bounded by the APT with the spallation-induced lithium conversion (SILC) target system shown in this figure.

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**FIGURE 4.3.3.9–1.—*High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Functions for Tritium Supply and Recycling Severe Accidents at Nevada Test Site.***

occur, there would be an estimated 0.011 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $3.3 \times 10^{-6}$ to an individual located at the site boundary during the accident. The risk to the population, taking the probability of the accident into account, is $6.8 \times 10^{-10}$ cancer fatalities per year (table 4.3.3.9–3).

Advanced Light Water Reactor. A range of accident sequences with various release categories was analyzed for the ALWR. One release category for a Large ALWR and one for a Small ALWR were selected to represent the accident consequences for an ALWR (appendix section F.2.1.3). In the event that such an accident were to occur, there would be an estimated 23 for a Large ALWR and 28.4 cancer fatalities for a Small ALWR, in the population within 50 miles and an increased likelihood of cancer fatality of $6.7 \times 10^{-3}$, for a Large ALWR and $7.7 \times 10^{-3}$ for a Small ALWR, to an individual located at the site boundary during the accident. The risk to the population, taking the probability of the accident into account, is $4.6 \times 10^{-7}$, cancer fatalities per year for a Large ALWR, and $5.7 \times 10^{-7}$, cancer fatalities per year for a Small ALWR (table 4.3.3.9–3).

Accelerator Production of Tritium with Helium-3 Target System. The large break loss of coolant accident with the total loss of the active emergency cooling system and the heat sink was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $9.0 \times 10^{-7}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $6.0 \times 10^{-10}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $9.0 \times 10^{-11}$ cancer fatalities per year (table 4.3.3.9–3).

Accelerator Production of Tritium with Spallation Induced Lithium Conversion Target System. The large break loss of coolant accident with a successful beam trip and the total loss of the active emergency cooling system was postulated as the high consequence accident for this APT and target option. In the

event that this accident were to occur, there would be an estimated $5.5 \times 10^{-6}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $4.5 \times 10^{-9}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $5.5 \times 10^{-10}$ cancer fatalities per year (table 4.3.3.9–3).

*Tritium Extraction and Recycling.* The tritium extraction facility is required to support all tritium supply technologies except the APT technology with the helium-3 target system. The tritium recycling facility is required to support all tritium supply technologies. The analyses of postulated high consequence accidents for the tritium extraction and recycling facilities at NTS are presented below.

Tritium Target Extraction Facility. An earthquake and release of process vessel tritium inventory postulated as the high consequence accident. In the event that this accident were to occur, there would be an estimated $1.2 \times 10^{-3}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatalities of $7.0 \times 10^{-7}$ to an individual who may be located at the site boundary. The risk to the population, taking the probability of an accident into account, is less than $1.2 \times 10^{-9}$ cancer fatalities per year (table 4.3.3.9–3).

Tritium Recycling Facility. An earthquake induced leak/ignition and fire in the unloading station carousel reservoir was postulated as the high consequence accident for the tritium recycling facility. In the event that this accident were to occur, there would be an estimated $4.1 \times 10^{-3}$ cancer facilities in the population with 50 miles and an increased likelihood of cancer fatality of $2.5 \times 10^{-6}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $4.1 \times 10^{-9}$ cancer fatalities per year (table 4.3.3.9–3).

For comparison purposes with high consequence tritium supply facility accidents, including extraction and recycling, for the same total population of 18,000 in the year 2050 within 50 miles of the site, there is a risk of 36 cancer fatalities per year from all other natural causes.

The analysis of facility accidents for tritium supply at NTS shows that, for high consequence accidents analyzed using the MACCS computer code, the ALWR has the highest consequences and risk and the APT has the lowest consequences and risk. The risk of accidents for any of the tritium supply technologies, tritium extraction, and tritium recycling facilities common to all technologies, is low when compared to the human risk of cancer fatalities from all other causes.

The consequences of operational basis or design basis accidents for the tritium extraction and recycling facilities at NTS are shown in table 4.3.3.9–4. The results in table 4.3.3.9–4 should not be compared with the severe accident analysis results in table 4.3.3.9–3 because different computer codes using different calculation approaches were used.

*Less Than Baseline Operations.* Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the HWR unless the baseline HWR core design was downsized. The baseline HWR configuration would adjust to the reduced target through-put requirements by reducing the time that the reactor is required to operate at 100 percent power. It is not anticipated that the overall risk from operating the reactor in this mode would decrease significantly. Accident analyses have not been performed to address accident sequences and initiating events when the reactor is in the cold shut down mode. In addition, operator error has a significant effect on facility risk and if the reactor is shutdown a high percentage of the time, operator error may actually increase when the reactor is at power.

Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the MHTGR or ALWR. The reactor surplus capacity would be used to generate steam for electric power production.

Less than baseline tritium operation would have no significant change to the MHTGR accident analyses because the analyses assumed that only one of the modules would be involved in the accident.

Less than baseline tritium operation would have no significant change to the APT accident analyses consequences. The accident consequences Full and

**TABLE 4.3.3.9–3.—*Tritium Supply Technologies and Recycling High Consequence/Low Probability Radioactive Release Accidents and Consequences at Nevada Test Site***

| Parameter | Tritium Supply Technologies | | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
|---|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | | |
| | | | Large | Small | Full | Phased | | |
| | | | | | Helium-3 Target System[f,g] | SILC Target System[h,i] | | |
| **Accident** | | | | | | | | |
| Frequency (per year) | $5.0\times10^{-8}$ | $6.0\times10^{-8}$ | $2.0\times10^{-8}$ | $2.0\times10^{-8}$ | $1.0\times10^{-4}$ | $1.0\times10^{-4}$ | $1.0\times10^{-6}$ | $1.0\times10^{-6}$ |
| **Consequence** | | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | | |
| Dose (rem) | 71 | 0.14 | 284 | 266 | $3.5\times10^{-5}$ | $4.0\times10^{-4}$ | 0.039 | 0.14 |
| Cancer fatalities | $1.8\times10^{-3}$ | $3.3\times10^{-6}$ | $6.7\times10^{-3}$ | $7.7\times10^{-3}$ | $6.0\times10^{-10}$ | $4.5\times10^{-9}$ | $7.0\times10^{-7}$ | $2.5\times10^{-6}$ |
| Risk (cancer fatalities per year) | $8.9\times10^{-11}$ | $2.0\times10^{-13}$ | $1.3\times10^{-10}$ | $1.5\times10^{-10}$ | $6.0\times10^{-14}$ | $4.5\times10^{-13}$ | $7.0\times10^{-13}$ | $2.5\times10^{-12}$ |
| ***Population Within 50 Miles*** | | | | | | | | |
| Dose (person-rem) | $1.3\times10^{4}$ | 22.7 | $4.6\times10^{4}$ | $5.7\times10^{4}$ | $1.8\times10^{-3}$ | 0.011 | 2.3 | 8.2 |
| Cancer fatalities | 6.4 | 0.011 | 23 | 28.4 | $9.0\times10^{-7}$ | $5.3\times10^{-6}$ | $1.2\times10^{-3}$ | $4.1\times10^{-3}$ |
| Risk (cancer fatalities per year) | $3.2\times10^{-7}$ | $6.8\times10^{-10}$ | $4.6\times10^{-7}$ | $5.7\times10^{-7}$ | $9.0\times10^{-11}$ | $5.3\times10^{-10}$ | $1.2\times10^{-9}$ | $4.1\times10^{-9}$ |

[a] For detailed HWR accident discussion see appendix section F.2.1.1.
[b] For detailed MHTGR accident discussion see appendix section F.2.1.2.
[c] For detailed ALWR accident discussion see appendix section F.2.1.3
[d] For detailed tritium target extraction facility discussion, see appendix section F.2.1.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.
[e] For detailed tritium recycling facility discussion, see appendix section F.2.3.
[f] For detailed APT with helium-3 target system discussion, see appendix section F.2.1.4.2.
[g] Analysis postulated the total failure of the active emergency cooling system and the loss of the heat sink.
[h] For detailed APT with spallation-induced lithium conversion target system discussion, see appendix section F.2.1.4.3.
[i] Analysis postulated successful beam trip with the total failure of the active emergency cooling system.
Note: SILC - spallation-induced lithium conversion.
Note: Model results.

**TABLE 4.3.3.9–4.—*Tritium Supply Technologies and Recycling Low to Moderate Consequence Radioactive Release Accidents and Consequences at Nevada Test Site***

| Parameter | Tritium Supply Technologies | | | | | | |
|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR/Large[c] | ALWR/Small | APT SILC Target System[f] | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
| **Accident** | | | | | | | |
| Description | Fuel Assembly failure during charge and discharge operations | Large break in primary system piping | Large break loss of coolant accident | Large break loss of coolant accident | Large break loss of coolant accident[g] | Deflagration[h] | Hybrid Bed Rupture |
| Frequency (per year) | 0.01 | 0.01 | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $2.0 \times 10^{-5}$ | $2.0 \times 10^{-4}$ |
| **Consequence** | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | |
| Dose (rem) | $8.4 \times 10^{-3}$ | $9.1 \times 10^{-3}$ | 2.3 | 0.098 | negligible | 0.043 | $1.9 \times 10^{-4}$ |
| Cancer fatalities | $4.2 \times 10^{-6}$ | $4.6 \times 10^{-6}$ | $1.1 \times 10^{-3}$ | $4.9 \times 10^{-5}$ | negligible | $2.2 \times 10^{-5}$ | $9.5 \times 10^{-8}$ |
| Risk (cancer fatalities per year) | $4.2 \times 10^{-8}$ | $4.6 \times 10^{-8}$ | $1.1 \times 10^{-6}$ | $4.9 \times 10^{-8}$ | negligible | $4.4 \times 10^{-10}$ | $9.5 \times 10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | |
| Dose (person-rem) | 3.2 | 3.4 | 830 | 37 | negligible | 16 | 0.07 |
| Cancer fatalities | $1.6 \times 10^{-3}$ | $1.7 \times 10^{-3}$ | 0.41 | 0.018 | negligible | $8.0 \times 10^{-3}$ | $3.5 \times 10^{-5}$ |
| Risk (cancer fatalities per year) | $1.6 \times 10^{-5}$ | $1.7 \times 10^{-5}$ | $4.1 \times 10^{-4}$ | $1.8 \times 10^{-5}$ | negligible | $1.6 \times 10^{-7}$ | $7.0 \times 10^{-9}$ |

[a] For detailed HWR accident discussion see appendix section F.2.2.1.

[b] For detailed MHTGR accident discussion see appendix section F.2.2.2.

[c] For detailed ALWR accident discussion see appendix section F.2.2.3

[d] For detailed tritium target extraction facility discussion, see appendix section F.2.2.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.

[e] For detailed tritium recycling facility discussion, see appendix section F.2.4.

[f] The APT with helium-3 target system bounding low to moderate consequence accident consequences are bounded by the APT with spallation-induced lithium conversion target system. For detailed APT discussion, see appendix section F.2.2.4.

[g] Analysis postulated all plant protection systems functioned as designed.

[h] Deflagration - intense rapid burning.

Note: SILC - spallation-induced lithium conversion.

Note: Model results.

Phased APT accidents with low to moderate consequences were negligible. For the beyond design basis accident, there was no difference in the Full and Phased accident sequences. Review of the source terms for the Full and Phased APT indicated that the tritium component of the source term is identical for both accidents. Review of the MACCS computer code output data for each accident analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results is negligible.

*Potential Mitigation Measures.* The accidents postulated for tritium supply technologies and recycling facilities are based on operation and safety analyses that have been performed at similar facilities. One of the major design goals for tritium supply and recycling facilities is to achieve a reduced risk to facility personnel and to public health and safety to as low as reasonably achievable.

Worker exposure that may result from the accidental release of radioactive material will be minimized through design features and administrative procedures that will be defined in conjunction with the facility design process. The radiological impacts to workers from accidents could not be estimated for this PEIS because the facility design information needed to support the estimate has not yet been developed. The impacts on workers from accidents will be analyzed as part of subsequent project-specific NEPA documentation and in detailed safety analysis documentation that are prepared in conjunction with the facility design process.

The tritium supply and recycling facilities would be designed to comply with current Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide facilities that are highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, high wind, as well as credible events as appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity for containing materials.

The tritium supply and recycling facilities would be designed to resist the effects of severe natural phenomena as well as the effects of man-made threats to its continuing structural integrity. It also would be designed to provide containment of the tritium inventory at all times through the use of multiple, high quality confinement barriers to prevent the accidental release of tritium to the environment. It also would be designed to produce a lower quantity of waste materials when compared with the tritium facilities of the existing weapons complex.

In addition, DOE orders specify the requirements for emergency preparedness at DOE facilities. NTS has comprehensive emergency plans to protect life and property within the facility and the health and welfare of surrounding areas. The emergency plans would be revised to incorporate future DOE requirements and expanded to incorporate the addition of tritium supply and recycling facilities to NTS. See section 4.3.2.9 for emergency preparedness and emergency plan details at NTS.

#### 4.3.3.10 *Waste Management*

Construction and operation of tritium supply and recycling facilities would impact existing NTS waste management operations, increasing the generation of low-level, mixed low-level, hazardous, and nonhazardous wastes, and initiating the generation of spent nuclear fuel. There are no high-level or TRU wastes associated with the proposed action. All reactor technologies would need to provide treatment and storage of spent nuclear fuel for the life of the facility. Spent nuclear fuel would be managed in accordance with DOE's decisions identified in the ROD after completion of the *Department of Energy Programmatic Spent Nuclear Fuel Management* and *Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS.* The impacts range from 13.5 acres per year LLW disposal for the HWR; increasing the quantity of hazardous waste generated by a factor of six for the MHTGR; to producing solid sanitary wastes at a rate that could require additional landfill capacity. The reactor technologies produce liquid LLW in quantities requiring new treatment facilities, and all technologies require treatment facilities for their liquid sanitary wastes. The volumes of mixed LLW for all technologies is small enough to be handled with the addition of an organic mixed waste treatment capability by existing and planned facilities as part of the compliance with the *Federal Facility Compliance Act* of 1992. This section provides a description of the waste generation, treatment, storage, and disposal requirements of

the tritium supply technologies and recycling facilities and the potential impacts on waste management at NTS.

**No Action.** Under No Action, mixed TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes would continue to be managed from the missions described in section 3.3.2. Receipt of wastes from other DOE sites would also continue. Table 4.3.3.10–1 lists the projected waste generation rates; and treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1991 environmental data with appropriate adjustments made for those changing operational requirements where the volume of wastes generated are identifiable. The projection does not include wastes from future yet uncharacterized, environmental restoration activities. The disposal of wastes received from offsite would not involve treatment at NTS, since these wastes must be treated, packaged, and certified to NTS waste acceptance criteria before they can be shipped to NTS for disposal. NTS has retrievable storage of TRU wastes awaiting shipment to a Federal repository. Although there is no generation of TRU wastes onsite, mixed TRU wastes from LLNL are presently stored at NTS. Mixed solid waste is stored awaiting treatment in a planned minimum technology facility. Hazardous waste is accumulated, then shipped offsite for disposal in a commercial RCRA-permitted facility. Nonhazardous and sanitary wastes are treated and disposed of locally in facilities located within the separate activity areas onsite.

**Tritium Supply and Recycling.** Tritium supply and recycling facilities that will support the nuclear weapons stockpile requirements (both new and existing facilities) would treat and package all waste generated from this activity into forms which would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other relevant statutes as outlined in chapter 5 and in appendix H, section H.1.2. The resultant waste effluents are shown in section 3.4. Waste generated during construction would consist of wastewater, nonhazardous solids, and hazardous waste. The nonhazardous wastes would be disposed as part of the construction project by the contractor, and the hazardous wastes would be shipped to a commercial RCRA-permitted treatment and disposal facility. Operation of the three reactor-based tritium supply technologies and recycling facilities would generate spent nuclear fuel, and all four technologies would generate low-level, mixed low-level, hazardous, and nonhazardous wastes. The volume of the waste streams from tritium supply would vary according to the technology chosen. Table 4.3.3.10–2 lists the total estimated waste volumes projected to be generated at NTS as a result of various tritium supply technologies and recycling facilities. The incremental waste volumes from the tritium supply and recycling facilities that were added to the No Action projection can be found in appendix section A.2. Table 4.3.3.10–3 lists potential waste management impacts at NTS at the time of initial operation of the tritium facilities. Spent nuclear fuel storage for the life of the reactor is provided for in the reactor designs (appendix section A.2.1). The interim management of spent nuclear fuel (pending the availability of a geologic repository) would be in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management* and *Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. Because spent nuclear fuel reprocessing is not planned, no HLW would be generated. Without plutonium production, no TRU waste would be generated. The treatment, storage, and disposal of mixed LLW would be in accordance with the NTS Site Treatment Plan which is currently being developed pursuant to the *Federal Facility Compliance Act* of 1992.

*Heavy Water Reactor.* Spent nuclear fuel would be generated at the rate of 7 $yd^3$ per year. The HWR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the HWR would require new treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides and prepare the solidified waste for disposal onsite. The solid onsite LLW generated would be increased to a rate that is 13 percent greater than the No Action volume. Assuming a 4,000 $ft^3$ per acre LLW disposal usage factor, this would require approximately 13.5 acres per year for onsite LLW disposal. A small amount of liquid mixed LLW is generated. This small volume could be handled by adding an organic mixed waste treatment capability within facilities being planned to comply with the *Federal Facility Compliance Act*. Mixed solid LLW volume is small enough to be

TABLE 4.3.3.10–1.—*Projected Waste Management Under No Action at Nevada Test Site*

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Mixed Transuranic** | None | None | None | Containers on asphalt pads | 1,485 | To repository | NA |
| **Low-Level** | | | | | | | |
| Liquid | Dependent on restoration activities | Not determined | None | Ponds | Sized to inventory | NA | NA |
| Solid | 42,400[a] | None | None | None | NA | Shallow burial | 156,741 plus 801,300 reserved for expansion |
| **Mixed Low-Level** | | | | | | | |
| Liquid | Included in solid | Evaporation, filtration, solidification | Being designed | Ponds | Being designed | NA | NA |
| Solid | 5,460 | None | NA | To be designed | To be designed | Minimum technology[b] | 222,220 |
| **Hazardous** | | | | | | | |
| Liquid | 38 (7,680 gal) | Contracted offsite | None | 90-day pad | 146[c] (29,500 gal) | Contracted offsite | NA |
| Solid | 20 | Contracted offsite | None | 90-day pad | 146[c] | Contracted offsite | NA |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | Included in solid | Septic fields | As required | None | NA | Septic fields | As required |
| Solid | 7,000 | None | None | NA | NA | Landfill onsite | As required |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | Included in sanitary | Septic fields | As required | None | NA | Septic fields | As required |
| Solid | 100,000 | None | None | NA | NA | NA | As required |

[a] Total onsite and offsite receipts.
[b] As required to meet RCRA requirements.
[c] Total capacity for solid and liquid hazardous wastes.
Note: NA - not applicable.
Source: DOE 1993a; DOE 1993c; NT DOE 1993d; NT MMES 1993a; NTS 1993a:4.

TABLE 4.3.3.10–2.—*Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for Tritium Supply Technologies and Recycling at Nevada Test Site*[a]

| Category | No Action ($yd^3$) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR ($yd^3$) | MHTGR ($yd^3$) | ALWR/Large ($yd^3$) | ALWR/Small ($yd^3$)[b] | APT ($yd^3$) |
| **Spent Nuclear Fuel** | None | 7 | 80 | 30 | 15 | None |
| **Low-Level** | | | | | | |
| Liquid | None[c] | 10,400[c] (2,100,000 gal) | 2,600[c] (525,000 gal) | 24,800[c] (5,000,000 gal) | 3,910[c] (790,000 gal) | None[c] |
| Solid | 42,400 | 48,000 | 44,100 | 43,500 | 43,400 | 43,300 |
| **Mixed Low-Level** | | | | | | |
| Liquid | Included in solid | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) |
| Solid | 5,460 | 5,580 | 5,460 | 5,470 | 5,470 | 5,470 |
| **Hazardous** | | | | | | |
| Liquid | 38 (7,680 gal) | 38 (7,680 gal) | 38 (7,680 gal) | 38 (7,680 gal) | 38 (7,680 gal) | 38 (7,680 gal) |
| Solid | 20 | 61 | 121 | 56 | 56 | 24 |
| **Nonhazardous (Sanitary)** | | | | | | |
| Liquid | Included in solid | 309,000 (62,300,000 gal) | 219,000 (44,300,000 gal) | 516,000 (104,000,000 gal) | 318,000 (64,300,000 gal) | 2,060,000 (415,000,000 gal) |
| Solid | 7,000 | 22,000 | 21,800 | 21,300 | 18,600 | 15,600 |
| **Nonhazardous (Other)** | | | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | 100,000 | 113,000[d] | 113,000[d] | 112,000[d] | 110,000[d] | 106,000[d] |

[a] The No Action waste volumes are from table 4.3.3.10–1. Waste volumes were derived by adding the waste volumes of the various alternatives found in appendix section A.2 (tables A.2.1.1–4, A.2.1.2–4, A.2.1.3–4, A.2.1.3–5, A.2.1.4–4, and A.2.2.1–4) to the No Action volumes. Waste volumes have been rounded to three significant figures.

[b] The APT and Recycling waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target waste volumes are approximately the same with the exception of solid LLW which is 42,800 $yd^3$.

[c] Additional liquid LLW may be generated from environmental restoration activities. The amount would depend on the level of effort and the treatment method selected.

[d] Includes recyclable wastes.

**TABLE 4.3.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from the Tritium Supply Technologies and Recycling at Nevada Test Site* [Page 1 of 2]**

| | Tritium Supply Technologies and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Spent Nuclear Fuel** | New | New storage facility | New | New storage facility | New | New storage facility | New | New storage facility | None | None |
| **Low-Level** | | | | | | | | | | |
| Liquid | New | New treatment facility required | New | New treatment facility required | New | New treatment facility required | New | New treatment facility required | None | None |
| Solid | +13 | 13.5 acres per year of LLW disposal required | +4 | 4.0 acres per year of LLW disposal required | +3 | 4.5 acres per year of LLW disposal required | +2 | 2.5 acres per year of LLW disposal required | +2 | 2.5 acres per year of LLW disposal required |
| **Mixed Low-Level** | | | | | | | | | | |
| Liquid | New | Additional treatment capability for organic mixed waste may be required | New | Additional treatment capability for organic mixed waste may be required | New | Additional treatment capability for organic mixed waste may be required | New | Additional treatment capability for organic mixed waste may be required | New | Additional treatment capability for organic mixed waste may be required |
| Solid | +2 | Additional treatment capability for organic mixed waste may be required | +<1 | Additional treatment capability for organic mixed waste may be required | +<1 | Additional treatment capability for organic mixed waste may be required | +<1 | Additional treatment capability for organic mixed waste may be required | +<1 | Additional treatment capability for organic mixed waste may be required |
| **Hazardous** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +205 | Additional storage facility | +505 | Additional storage facility | +180 | Additional storage facility | +180 | Additional storage facility | +18 | Enlarge storage facility |

TABLE 4.3.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from the Tritium Supply Technologies and Recycling at Nevada Test Site* [Page 2 of 2]

| | Tritium Supply Technologies and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Nonhazardous (Sanitary)** | | | | | | | | | | |
| Liquid | New | New treatment facility required | New | New treatment facility required | New | New treatment facility required | New | New treatment facility required | New | New treatment facility required |
| Solid | +214 | Landfill life reduced or, expansion required | +211 | Landfill life reduced or, expansion required | +204 | Landfill life reduced or, expansion required | +166 | Landfill life reduced or, expansion required | +123 | Landfill life reduced or, expansion required |
| **Nonhazardous (Other)** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +13 | None - Project wastes are recyclable | +13 | None - Project wastes are recyclable | +12 | None - Project wastes are recyclable | +10 | None - Project wastes are recyclable | +6 | None - Project wastes are recyclable |

[a] This column reflects the percentage change in generation rate over No Action. Percentage change was calculated using waste volumes prior to rounding. Do not use rounded numbers in table 4.3.3.10–2 to calculate percentage change.

Source: Tables 4.3.3.10–1 and 4.3.3.10–2.

handled by existing and planned facilities pursuant to compliance with the *Federal Facility Compliance Act* of 1992. Hazardous waste generation would increase by a factor of 3. This would require a permitted storage facility where the waste can be packaged for shipment to a commercial RCRA-permitted treatment and disposal facility. Liquid sanitary wastes generated by the HWR would require new treatment facilities since NTS does not have centralized facilities for these wastes. The volume of solid sanitary wastes generated would increase approximately by a factor of three more than No Action. This could reduce the remaining useful life of the landfill or require a proportional expansion.

Siting an HWR without tritium recycling facilities at NTS would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.3.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 3 to a factor of 2; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Modular High Temperature Gas-Cooled Reactor.* Spent nuclear fuel would be generated at the rate of 80 $yd^3$ per year. The MHTGR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The liquid LLW generation would require a new treatment facility, to concentrate and stabilize this waste. Solid LLW generation at NTS would increase to a rate 4 percent greater than No Action. It would be treated and disposed of onsite, and would require 4 acres per year of LLW disposal. The small volume of liquid mixed LLW could be handled by adding an organic mixed waste treatment capability within facilities being planned to comply with the *Federal Facility Compliance Act.* Mixed solid LLW volumes are small enough to be handled by adding an organic mixed waste treatment capability to existing and planned facilities pursuant to compliance with the *Federal Facility Compliance Act* of 1992. The generation of hazardous waste would increase to a level six times greater than No Action. This would require a RCRA-permitted facility where the waste can be staged for shipment to a commercial RCRA-permitted treatment and disposal facility. Liquid sanitary nonhazardous wastes generated by the MHTGR would require new treatment facilities since NTS does not have centralized facilities for these wastes. The volume of sanitary nonhazardous solid wastes generated would increase by a factor of three greater than No Action. This could reduce the remaining useful life of the landfill or require a proportional expansion.

Siting an MHTGR without tritium recycling facilities at NTS would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.3.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 3 to a factor of 2; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Advanced Light Water Reactor (Large).* Spent nuclear fuel would be generated at the rate of 30 $yd^3$ per year. The Large ALWR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require new treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides to prepare the waste for disposal onsite. The solid LLW generation rate would increase by 3 percent more than the No Action rate. This would require 4.5 acres per year of LLW disposal. The small volume of liquid mixed LLW could be handled by adding an organic mixed waste treatment capability within facilities being planned to comply with the *Federal Facility Compliance Act.* Mixed solid LLW volume is small enough to be handled by adding an organic mixed waste treatment capability to existing and planned facilities pursuant to compliance with the *Federal Facility Compliance Act* of 1992.

Hazardous wastes would be generated at a rate almost three times the No Action rate. This would require a RCRA-permitted facility to prepare the waste for shipment to a commercial RCRA-permitted treatment and disposal facility. Liquid sanitary nonhazardous wastes generated by the ALWR would require separate treatment and disposal facilities since NTS does not have centralized facilities for these wastes. The solid sanitary nonhazardous wastes generated by the ALWR increases the disposal at NTS to a rate that is three times the No Action generation. This could reduce the remaining useful life of the landfill or require a proportional expansion.

Siting a Large ALWR without tritium recycling facilities at NTS would not affect the generation of nor change the impacts from spent nuclear fuel as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.3.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 3 to a factor of almost 2; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Advanced Light Water Reactor (Small).* Spent nuclear fuel would be generated at the rate of 15 $yd^3$ per year. The Small ALWR would be designed to provide the necessary treatment and storage of the Spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require new treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides to prepare the waste for disposal onsite. The solid LLW volume would increase the generation rate at NTS by 2 percent more than the No Action volume and would require 2.5 acres per year of LLW disposal. The small volume of mixed liquid LLW generated by the ALWR could be handled by adding an organic mixed waste treatment capability within facilities being planned to comply with the *Federal Facility Compliance Act*, since there are no facilities planned for this purpose at NTS. The ALWR solid mixed LLW generation would cause the rate at NTS to increase by less than 1 percent above No Action. With an added organic mixed waste treatment capability, existing/planned facilities would be adequate. Hazardous waste would be generated at a rate of almost three times the No Action rate. This would require a RCRA-permitted facility where the waste can be staged for shipment to a commercial RCRA-permitted treatment and disposal facility. Liquid sanitary nonhazardous wastes generated by the Small ALWR would require new treatment and disposal facilities because NTS does not have centralized facilities for these wastes. The solid sanitary nonhazardous wastes generated by the Small ALWR would increase by a factor of two and one-half more than No Action generation. This could reduce the remaining useful life of the landfill or require a proportional expansion.

Siting a Small ALWR without tritium recycling facilities at NTS would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.3.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of two and one-half to 60 percent; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Accelerator Production of Tritium.* The APT would not generate spent nuclear fuel. Any liquid LLW can be solidified at the point of generation. The APT generated solid LLW would increase the volume disposed at NTS by 2 percent more than No Action. This would require 2.5 acres per year of LLW disposal. A small amount of liquid LLW generated could be treated at the point of generation. The solid mixed LLW volume is small enough to be handled by adding an organic mixed waste treatment capability to existing and planned facilities pursuant to compliance with the *Federal Facility Compliance Act* of 1992. There would be no liquid hazardous waste generation. Solid hazardous waste generation would be increased by 18 percent over No Action. An

expansion of existing or planned RCRA-permitted facilities could be required where the hazardous wastes are staged for shipment to a commercial RCRA-permitted treatment and disposal facility. Liquid sanitary nonhazardous wastes generated by the APT would require new treatment and disposal facilities because NTS does not have centralized facilities for these wastes. When the volume of solid sanitary nonhazardous wastes is added to No Action, the generation increases by a factor of two. This would require additional or expansion of existing landfill facilities.

Siting an APT without tritium recycling facilities at NTS would not affect the generation of nor change the impacts from liquid LLW as described above and in table 4.3.3.10–3. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.3.3.10–3. The LLW disposal area required for solid LLW would decrease by approximately 1 acre per year. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 2 to 18 percent; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Less Than Baseline Operations.* In the event of a reduced baseline tritium requirement the waste volumes shown in table 4.3.3.10–2 would not appreciably change as a result of the HWR operating at less power, and the MHTGR and ALWR irradiating fewer target rods. In the case of a Phased APT using the helium-3 target, the waste volumes are approximately the same as the Full APT using the helium-3 target.

**Potential Mitigation Measures.** Each tritium supply technology and recycling facility would be designed to process its own waste into forms suitable for long-term storage or disposal and would use proven waste minimization and pollution prevention technologies to the extent possible. Some facility designs would produce waste quantities or waste forms that could undergo additional reductions by utilizing emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be major factors in determining the final design of any facility constructed as part of the proposed action at NTS. Pollution prevention and waste minimization would also be analyzed as part of the site-specific analyses and tiered NEPA documents.

NTS has a very limited onsite treatment capability. The plans for remediation of inactive waste disposal areas will be formulated over the next three and a half years, and these plans will likely result in changes (from current practices) in waste generation, treatment, storage, and disposal at NTS by the time tritium facilities begin operation. A mixed waste treatment facility is planned, and accommodation of the small amount of mixed LLW from the tritium facility would have a minor impact. The use of existing facilities for the staging of hazardous wastes could be considered, although the volume generated by the tritium facilities is sufficient that new facilities may be more feasible. Utilization of any of these facilities would require site-specific engineering studies and would be analyzed in site-specific tiered NEPA documents.

## 4.4 Oak Ridge Reservation

ORR was established in 1942 and is located on approximately 35,000 acres within the city boundaries of Oak Ridge, TN. Of the three major facilities on ORR, the Y-12 Plant is the primary location of the defense program missions. The Y-12 assignment includes the dismantling of nuclear weapons components returned from the Nation's arsenal, maintaining nuclear production capability and stockpile support, storing special nuclear materials, and providing special manufacturing support to DOE programs. Section 3.3.4 describes the other missions at ORR. DOE's property boundaries for ORR are illustrated in figure 4.4–1.

### 4.4.1 Description of Alternatives

Under the proposed action, any one of the four tritium supply technologies (HWR, MHTGR, ALWR, or APT) could be sited at ORR alone or collocated with a new tritium recycling facility. Section 3.4.2 provides a description of the tritium supply technologies and section 3.4.3.1 describes the tritium recycling facility. Figure 4.4.1–1 shows the location of existing facilities within ORR and the TSS.

Under No Action, ORR would continue to perform the missions described in section 3.3.4. There are no facilities at ORR that would be phased out as a result of any of the proposed action alternatives discussed in the PEIS.

### 4.4.2 Affected Environment

The following sections describe the affected environment at ORR for land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure at ORR, the radiation and hazardous chemical environment, and the waste management conditions are described.

#### 4.4.2.1 *Land Resources*

The discussion of land resources at ORR includes land use and visual resources.

**Land Use.** ORR is located on approximately 35,000 acres within the corporate limits of the city of Oak Ridge, approximately 12 miles west of Knoxville, TN. All the land within ORR is owned by the Federal government and is administered, managed, and controlled by DOE. Generalized land uses at ORR and in the vicinity are shown in figure 4.4.2.1–1.

Land uses within ORR can be grouped into four major land use classifications: industrial, forest/undeveloped, public/quasi-public, and water. The industrial areas account for approximately 11,700 acres or 33.1 percent of the total site acreage. An additional 1,200 acres (3.5 percent) are used for a security buffer zone around various facilities. About 800 acres (2.2 percent) of ORR's land is classified as public land and consists mainly of the 90-acre Clark Center Recreational Park, numerous small public cemeteries, and an onsite public road (OR DOE 1989b:5-10). The remaining area, about 21,600 acres (61.2 percent), consists of forest/undeveloped land, some of which is managed as pine plantations for production of pulpwood and saw timber. The DOE water treatment facility, which provides water to many ORR facilities and the city of Oak Ridge, is located just north of Y-12. There are no prime farmlands on ORR.

In 1980, DOE designated approximately 13,600 acres of ORR undeveloped land as a National Environmental Research Park. The National Environmental Research Park is used by the national scientific community as an outdoor laboratory for environmental science research on the impact of human activities on the eastern deciduous forest ecosystem (DOE 1985a:3,27).

The proposed 600-acre TSS would be located within the west-central portion of ORR, between K-25 and Oak Ridge National Laboratory (figure 4.4.2.1–1) on forest/undeveloped land. The current primary land uses are environmental research and cultivation of pine plantations. A portion of the siting area, south of the Bear Creek Valley Road and west of State Route 95, is part of the National Environmental Research Park. There are two cemeteries within the area. There are three utility easements and also rights of way for State Routes 58, 95, and 327 (Blair Road) (OR DOE 1991f:2-6).

ORR has other facilities planned including proposed short-range projects (1995 through 1999) and potential long-range projects (2000 and beyond).

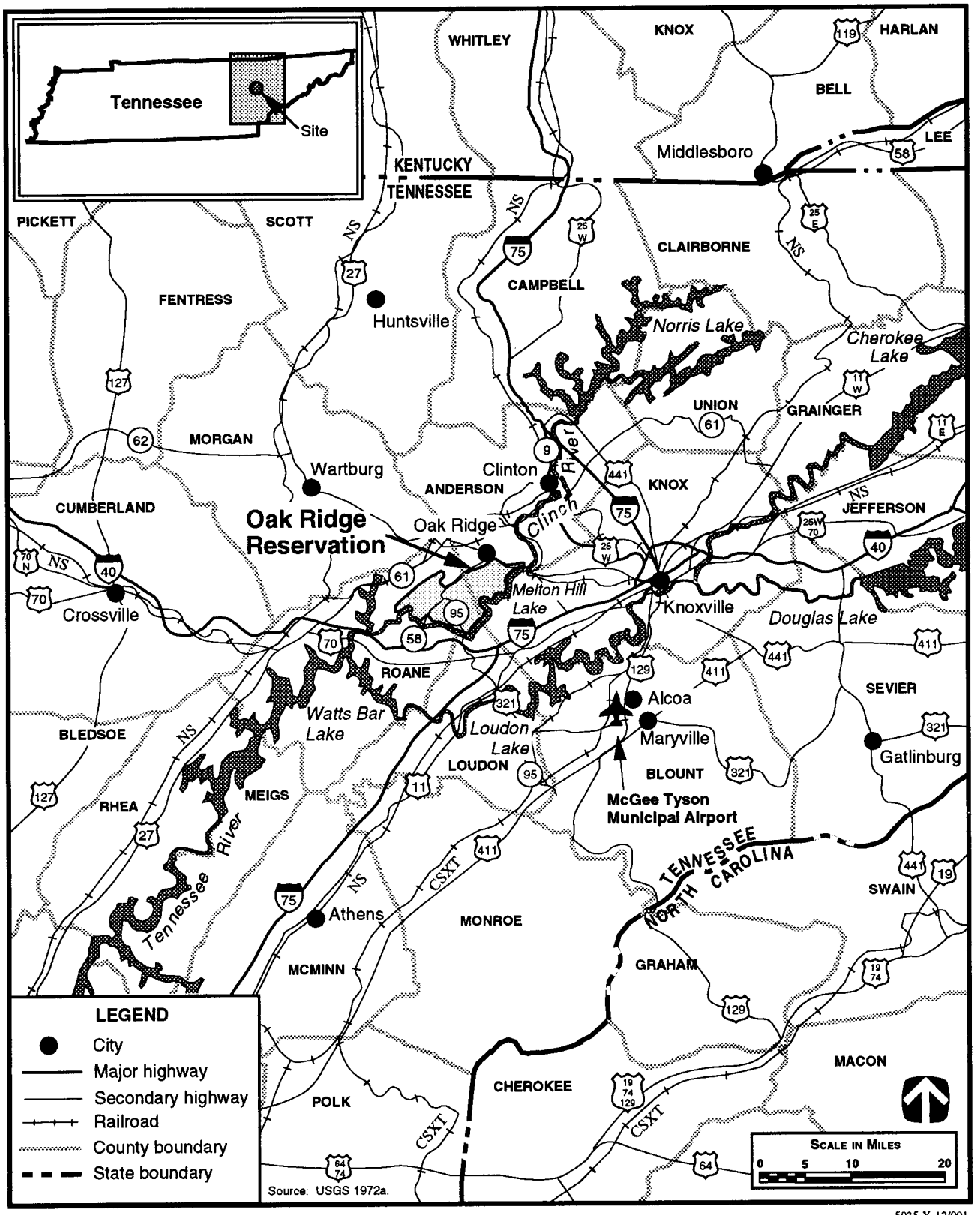



**FIGURE 4.4–1.—*Oak Ridge Reservation, Tennessee, and Region.***

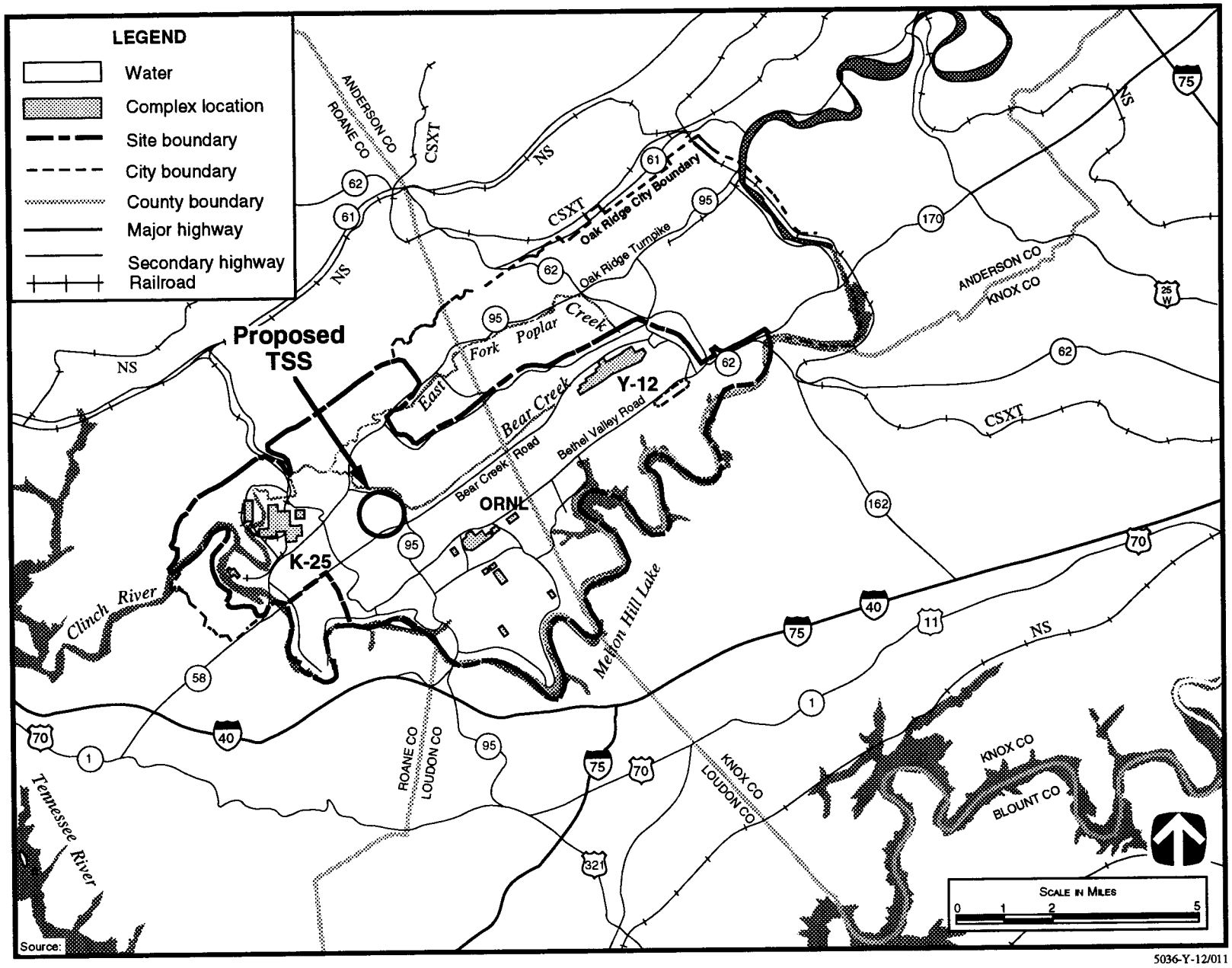
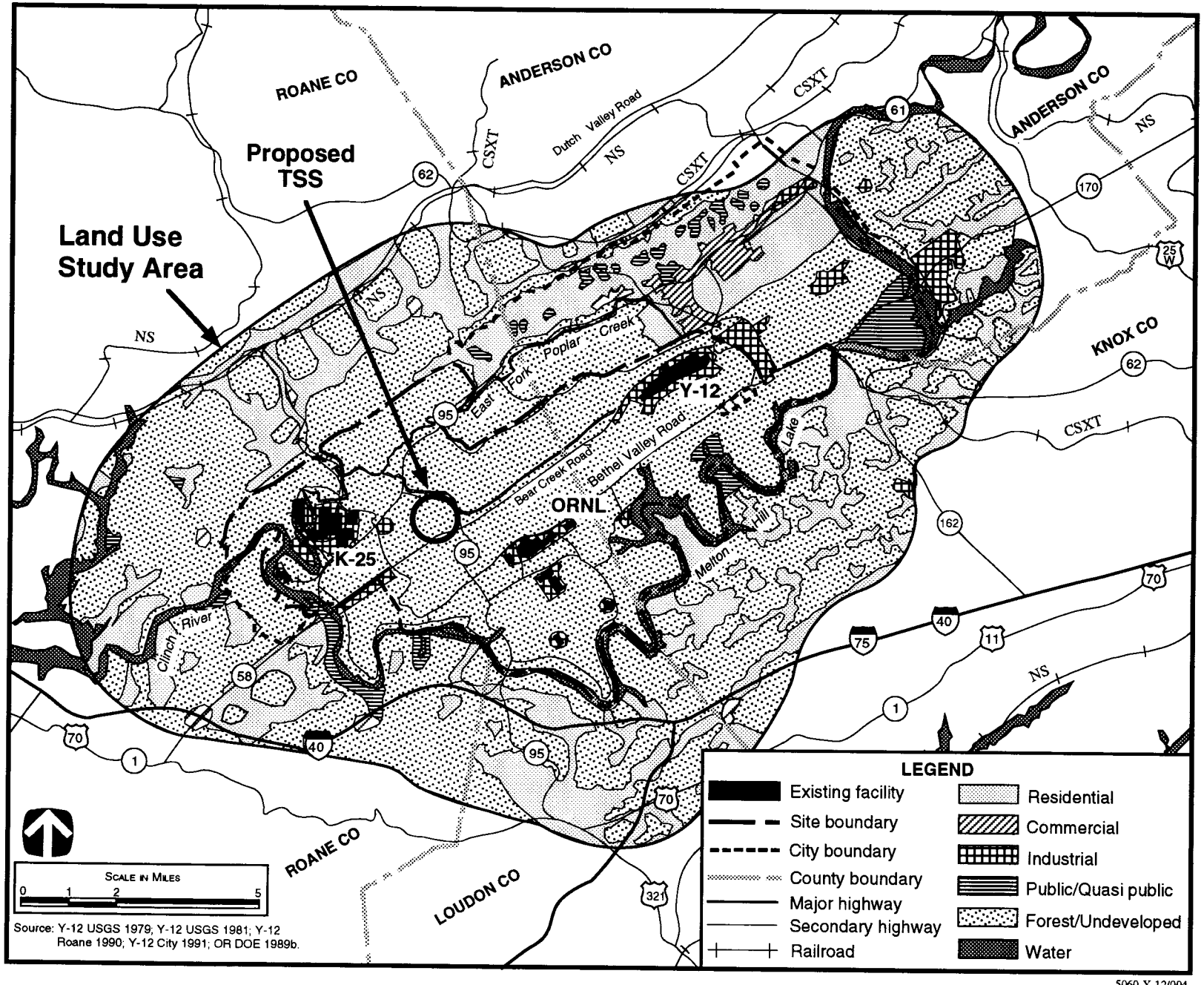



FIGURE 4.4.1–1.—*Primary Facilities and Proposed Tritium Supply Site at Oak Ridge Reservation.*




Source: Y-12 USGS 1979; Y-12 USGS 1981; Y-12 Roane 1990; Y-12 City 1991; OR DOE 1989b.

5060-Y-12/004

**FIGURE 4.4.2.1–1.**—*Generalized Land Use at Oak Ridge Reservation and Vicinity.*

The short-range projects include the uranium-atomic vapor laser isotope separation facility, consolidated central firearms and guard training facility, transportation and maintenance facility, life sciences facilities (phase one), advanced neutron source facility, and expanded Oak Ridge National Laboratory research facilities (phase one). Long-range projects include the depleted uranium recycle facility, fossil fuel liquefaction facility, central shipping/receiving facility, and administrative office complex. Figure 4.4.2.1–2 shows proposed development in relation to existing ORR facilities and the proposed TSS.

Land bordering ORR is predominately rural and used largely for residences, small farms, forest land, and pasture land. The city of Oak Ridge, along the northeast portion of the site, has a typical urban mix of residential, public, commercial, and industrial land uses. There are four residential areas along the northern boundary of ORR; each has several houses within 100 feet of the boundary.

**Visual Resources.** The ORR landscape is characterized by a series of ridges and valleys that trend in a northeast-to-southwest direction. The vegetation is dominated by deciduous forest mixed with some coniferous forest. Much of ORR's open fields (about 5,000 acres) have been planted in shortleaf and loblolly pine; smaller areas have been planted in a variety of deciduous and coniferous trees (OR DOE 1989b:3-14). The DOE facilities are brightly lit at night, making them especially visible. The developed areas of ORR are consistent with Bureau of Land Management's Class 5 VRM designation. The remainder of ORR ranges from a VRM Class 3 to Class 4 designation. Portions of the proposed TSS where contrasts caused by development activity are evident, but subordinate to the natural landscapes, are consistent with VRM Class 3. Other portions that have roads and utility lines that attract the attention of the viewer are designated VRM Class 4.

The viewshed consists mainly of rural land. The city of Oak Ridge is the only adjoining urban area. Viewpoints affected by DOE facilities are primarily associated with the public access roadways, the Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River. Views are limited by the hilly terrain, heavy vegetation, and generally hazy atmospheric conditions. Some partial views of the DOE water treatment plant facilities can be seen from the urban areas of the city of Oak Ridge.

#### 4.4.2.2 *Site Infrastructure*

Section 3.3.4 describes the current missions at ORR. To support these missions, an extensive infrastructure exists as shown in table 4.4.2.2–1. Of critical importance to the proposed action is the electrical power capacities and reserves at each site. The regional electric power pool area in which ORR is located and from which it draws its power is the Tennessee Valley Authority Subregion. Characteristics of this power pool are given in table 4.4.2.2–2.

#### 4.4.2.3 *Air Quality and Acoustics*

The following describes existing air quality and acoustics including a review of the meteorology and climatology in the vicinity of ORR. More detailed discussions of the air quality and acoustics methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.1.3.4.

**Meteorology and Climatology.** The Cumberland and Great Smoky Mountains have a moderating influence on the climate at ORR. Winters are generally mild and summers warm, with no noticeable extremes in precipitation, temperature, or winds.

**TABLE 4.4.2.2–1.—*Baseline Characteristics for Oak Ridge Reservation***

| Current Characteristics | Value |
|---|---|
| **Land** | |
| Area (acres) | 34,709 |
| Roads (miles) | 43 |
| Railroads (miles) | 17 |
| **Electrical** | |
| Energy consumption (MWh/yr) | 12,368,800 |
| Peak load (MWe) | 1,411 |
| **Fuel** | |
| Natural gas ($ft^3$/yr) | 3,122,000,000 |
| Oil (GPY) | 980,600 |
| Coal (ton/yr)[a] | 25,000 |
| **Steam** (lb/hr) | 340,000 |

[a] Oil and coal availability is unlimited, figures are for current use.

Source: ORR 1993a:8.

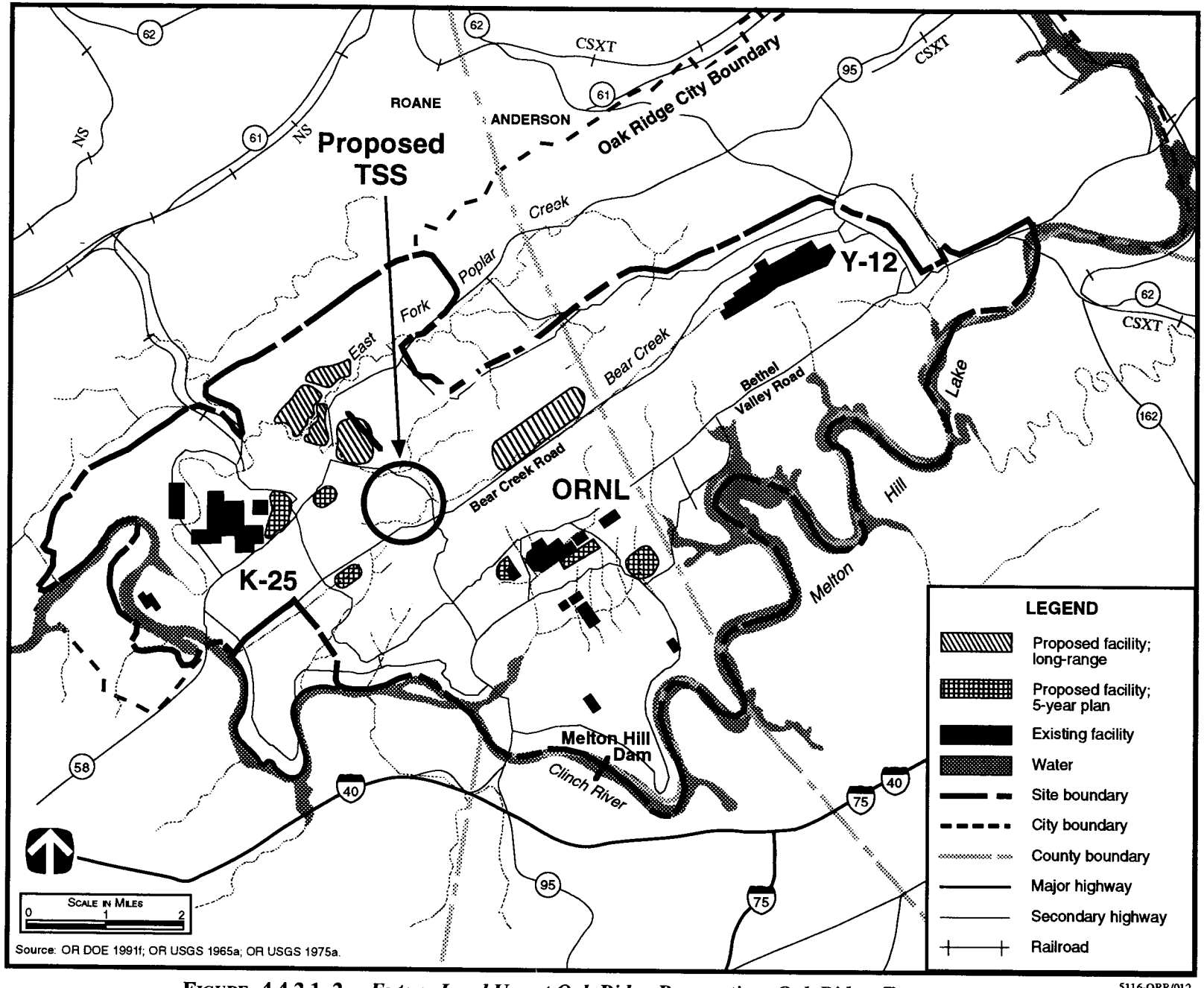



**FIGURE 4.4.2.1–2.**—*Future Land Use at Oak Ridge Reservation, Oak Ridge, Tennessee.*

5116-ORR/012

**TABLE 4.4.2.2–2.—*Regional Power Pool Electrical Summary for Oak Ridge Reservation***

| Type Fuel | Production[a] (percent) |
|---|---|
| Coal | 49 |
| Nuclear | 39 |
| Hydro/geothermal | 11 |
| Oil/gas | <1 |
| Other[b] | 0 |
| **Total Annual Production:** 159,842,000 MWh | |
| **Total Annual Load:** 156,987,000 MWh | |
| **Energy Exported Annually[c]:** 2,407,000 MWh | |
| **Generating Capacity:** 33,370 MWe | |
| **Peak Demand:** 28,127 MWe | |
| **Capacity Margin[d]:** 4,550 MWe | |

[a] Does not total 100 percent due to round-off error.
[b] Includes power from both utility and nonutility sources.
[c] Energy exported is not the difference of production and load due to system losses and pumped storage.
[d] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

The annual average temperature at ORR is 57.5 °F; the average daily minimum temperature in January is 27.7 °F, and the average daily maximum temperature in July is 87.2 °F. The average annual precipitation is approximately 54.8 inches (NOAA 1991c). Prevailing wind directions at ORR tend to follow the orientation of the valley; up valley, from west to southwest, or down valley, from east to northeast. The annual average wind speed is approximately 4.6 mph. Additional information related to meteorology and climatology at ORR is presented in appendix section B.1.3.4.

**Ambient Air Quality.** ORR is located in Anderson and Roane Counties in the eastern Tennessee and southwestern Virginia Interstate AQCR 207. As of 1991, the areas within this AQCR were designated as attainment with respect to all NAAQS for criteria pollutants (40 CFR 81.343). Applicable NAAQS and Tennessee state ambient air quality standards are presented in appendix table B.1.3.1–1.

One Prevention of Significant Deterioration Class I area can be found in the vicinity of ORR. This area, the Great Smoky Mountains National Park, is located approximately 30 miles east of ORR. Since the promulgation of regulations, no Prevention of Significant Deterioration permits have been required for any emissions source at ORR.

Ambient air quality monitoring data collected at ORR during 1989 and 1990 are summarized in appendix table B.1.3.4–1. The primary emission sources of criteria pollutants are the steam plants at K-25, Y-12, and the Oak Ridge National Laboratory. Other emission sources include fugitive particulates from coal piles, the TSCA incinerator, other processes, vehicles, and temporary emissions from various construction activities (OR DOE 1987a). Appendix table B.1.3.4–2 presents emissions of criteria pollutants from ORR.

Table 4.4.2.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at ORR. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

**Acoustic Conditions.** Major noise emission sources within ORR include various industrial facilities, equipment, and machines. At the site boundary, noise emitted from the site is barely distinguishable from background noise levels of 35 to 50 dBA. Areas near the site that are within the city of Oak Ridge are typical of a suburban area. The primary source of noise at the site boundary and at residences near roads is traffic. During peak hours, the plant traffic is a major contribution to traffic noise levels in the area.

The State of Tennessee has not established specific numerical environmental noise standards applicable to ORR. The city of Oak Ridge has specific acceptable sound levels at property lines.

### 4.4.2.4 *Water Resources*

This section describes the surface water and groundwater resources at ORR.

**Surface Water.** The major surface water body in the immediate vicinity of ORR is the Clinch River, which borders the site to the south. There are four major sub-drainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek (ORR 1992a:5). Two smaller drainage basins, Ish Creek and Grassy Creek, drain

**TABLE 4.4.2.3–1.—*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Oak Ridge Reservation, 1992***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Baseline Concentration[a] ($\mu g/m^3$) |
|---|---|---|---|
| **Criteria Pollutant** | | | |
| Carbon monoxide (CO) | 8-hour | 10,000[b] | 5 |
| | 1-hour | 40,000[b] | 11 |
| Lead (Pb) | Calendar Quarter | 1.5[b] | 0.05[c] |
| Nitrogen dioxide ($NO_2$) | Annual | 100[b] | 3 |
| Ozone ($O_3$) | 1-hour | 235[b] | [d] |
| Particulate matter ($PM_{10}$) | Annual | 50[b] | 9 |
| | 24-hour | 150[b] | 56 |
| Sulfur dioxide ($SO_2$) | Annual | 80[b] | 29 |
| | 24-hour | 365[b] | 105 |
| | 3-hour | 1,300[b] | 401 |
| **Mandated by Tennessee** | | | |
| Total suspended particulates (TSP) | Annual | 60[e] | 33 |
| | 24-hour | 150[e] | 75 |
| Hydrogen fluoride (as fluorides) | 30-day | 1.2[e] | 0.2 |
| | 7-day | 1.6[e] | 0.3 |
| | 24-hour | 2.9[e] | [f] |
| | 12-hour | 3.7[e] | [f] |
| | 8-hour | 250[e] | 0.60 |
| **Hazardous and Other Toxic Compounds** | | | |
| CFC-11 | 8-hour | 562,000[e] | 46.2 |
| CFC-114 | 8-hour | 699,000[e] | 24.1 |
| Chlorine | 8-hour | 150[e] | 4.1 |
| Chlorodifluoromethane | 8-hour | 354,000[e] | 16.4 |
| Dichlorodifluoromethane | 8-hour | 495,000[e] | 10.5 |
| Hydrogen chloride | 8-hour | 750[e] | 57 |
| Methyl alcohol | 8-hour | 26,200[e] | 216 |
| Nitric acid | 8-hour | 520[e] | 78 |
| Sulfuric acid | 8-hour | 100[e] | 20 |
| Tetrachloroethylene | 8-hour | 33,900[e] | 100 |
| Trichloroethane | 8-hour | 191,000[e] | 6.1 |
| Trichlorotrifluoroethane | 8-hour | 767,000[e] | 10.1 |

[a] The baseline concentration represents a conservative assessment of air quality since the contributions from individual sources do not necessarily occur at the same location.
[b] Federal standard (40 CFR 50).
[c] Value is maximum for 24-hour period.
[d] No monitoring data available.
[e] State standard (OR DHE 1991a).
[f] Data unavailable.
Source: OR DOE 1993a.

directly to the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. Within each basin is a number of small tributaries. The natural surface water bodies in the vicinity of ORR are shown on figure 4.4.2.4–1.

The three existing DOE complexes on ORR each affect different basins of the Clinch River. Drainage from Y-12 enters both Bear Creek and East Fork Poplar Creek; K-25 drains predominantly into Poplar Creek; and Oak Ridge National Laboratory drains into the White Oak Creek drainage basin.

The proposed TSS lies within the central portion of ORR in an area drained by tributaries of Grassy, Ish, and Bear Creeks. No buildings or structures are currently located within the candidate area (OR DOE 1991c).

The Clinch River and connected waterways supply all raw water for ORR. The Clinch River has an average flow of 4,882 $ft^3/s$ (OR USGS 1986a). The average flows of Grassy, Ish, and Bear Creeks near the proposed site are 2.82 $ft^3/s$, 1.77 $ft^3/s$, and 3.22 $ft^3/s$, respectively. The average flow at East Fork Poplar Creek is 51.4 $ft^3/s$. ORR and the city of Oak Ridge use approximately 18.3 MGD of water; the ORR water supply system, which includes the DOE treatment facility and the K-25 treatment facility, has a capacity of 32.1 MGD.

Wastewater treatment facilities are located throughout ORR. At Y-12, there are six treatment facilities with NPDES-permitted discharge points to East Fork Poplar Creek. Y-12 also has a permit to discharge wastewater to the Oak Ridge Treatment Facility. At Oak Ridge National Laboratory, there are three NPDES-permitted wastewater treatment facilities discharging into White Oak Creek basin. K-25 operates one sanitary sewage system discharging to Poplar Creek (OR DOE 1992c).

Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the Tennessee Valley Authority. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam, on the Tennessee River near the lower end of the Clinch River, controls the flow of the Clinch River along the southeast side of ORR (ORNL 1986a).

The Tennessee Valley Authority has conducted flood studies along the Clinch River, Bear Creek, and East Fork Poplar Creek (OR TVA 1991a). Portions of Y-12 lie within the 100- and 500-year floodplains of East Fork Poplar Creek *(Oak Ridge Y-12 Technical Site Information*, Y/EN-SFPI). Studies have not been performed to delineate the 100- or 500-year floodplain boundaries of Grassy, Ish, and Bear Creeks near the proposed TSS (OR DOE 1991c). A site-specific assessment would be required before constructing any tritium supply and recycling facility at ORR.

**Surface Water Quality.** The streams and creeks of Tennessee are classified by the Tennessee Department of Environment and Conservation and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. The Clinch River is the only surface water body on ORR classified for domestic water supply. Streams at ORR are classified for fish, aquatic life, and livestock watering; irrigation; recreation; and wildlife. White Oak Creek and Melton Branch are the only streams not classified for irrigation. Portions of Poplar Creek, East Fork Poplar Creek, and Melton Branch are not classified for recreation (OR DOE 1992c).

ORR streams receive effluents from treated sanitary wastewater, industrial discharges, cooling water blowdown, stormwater, surface water runoff, and groundwater (OR DOE 1991f). At Y-12, Bear Creek, McCoy Branch, Rogers Quarry, and East Fork Poplar Creek receive effluents (OR DOE 1993a).

There were three primary areas of NPDES noncompliances at Y-12: creek outfalls, discharges from Rogers Quarry, and discharges from wastewater treatment facilities. Observable excursions along East Fork Poplar Creek consisted primarily of discharges of visible foam or oil sheens. The foam noncompliance occurred as a result of numerous sinks being tied to the storm sewer system. Most oil sheen noncompliances were the result of parking lot runoff (OR DOE 1993a). A building drain identification survey has been started to address the foam problem. Noncompliance of the discharge from Rogers Quarry as a result of elevated pH levels is believed to be caused by algae growth. A subsurface discharge pipe has been installed to allow deeper, $CO_2$-rich water to be discharged (OR DOE 1992c). Noncompliances with wastewater treatment facilities discharge limits

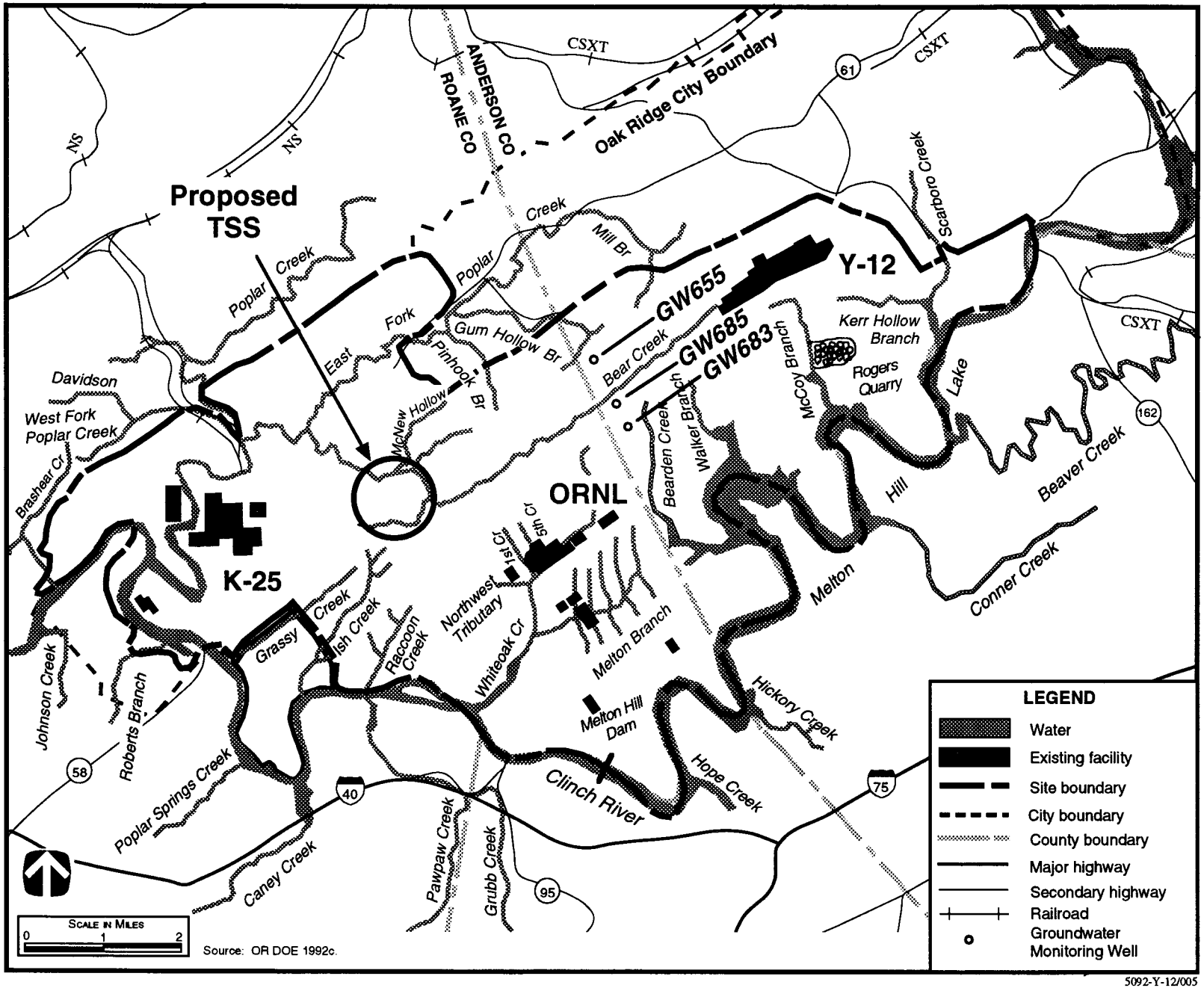



FIGURE 4.4.2.4–1.—*Surface Water Features at Oak Ridge Reservation.*

are being addressed by better operational controls and preventive maintenance programs (OR DOE 1993a).

As shown in table 4.4.2.4–1, concentrations of copper, mercury, zinc, and dissolved solids exceed both chronic and acute (where applicable) state water quality criteria where the Clinch River leaves ORR. Monitoring data from this sampling site were compared with data from the Melton Hill Dam sampling site, located upstream of all ORR discharges. Concentrations at Melton Hill Dam were well below applicable water quality criteria.

**TABLE 4.4.2.4–1.—*Summary of Surface Water Quality Monitoring at Oak Ridge Reservation***

| | Receiving Water: Clinch River, 1991 | | |
|---|---|---|---|
| **Parameter** | **Unit of Measure** | **Water Quality Criteria[a]** | **Average Water Body Concentration** |
| Alpha (gross) | pCi/l | 15[b] | 0.416 |
| Beta (gross) | pCi/l | 50[c] | 0.563 |
| Cesium-137 | pCi/l | 120[d] | 7.63 |
| Chemical oxygen demand | mg/l | NA | 11,071 |
| Copper[e] (acute/chronic) | mg/l | 0.018[f]/0.012[f] | 5.5/5.2 |
| Dissolved solids | mg/l | 500[f] | 140,000 |
| Fluoride | mg/l | 4.0[b] | 100 |
| Manganese | mg/l | 0.05[g] | 49.3 |
| Mercury[e] (acute/chronic) | mg/l | 0.0024[f]/0.000012[f] | 0.24/0.24 |
| Neptunium-237 | pCi/l | 1.2[d] | -0.0378[h] |
| Nitrate | mg/l | 10.0[b] | 0.373 |
| pH | pH units | 6.5-8.5[g] | 8.04 |
| Plutonium-238 | pCi/l | 1.6[d] | -1.23[h] |
| Plutonium-239 | pCi/l | 1.2[d] | -0.026[h] |
| Sodium | mg/l | NA | 4,393 |
| Sulfate | mg/l | 250[g] | 21,333 |
| Suspended solids | mg/l | NA | 17,917 |
| Technetium-99 | pCi/l | 4,000[d] | -258.16[h] |
| Uranium, Total | mg/l | NA | 0.001 |
| Zinc[e] (acute/chronic) | mg/l | 0.117[f]/0.106[f] | 14/8.05 |

[a] For comparison only, except for parameters which have state water quality criteria.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] Proposed National Primary Drinking Water Regulations, Radionuclides (56 FR 33050).

[d] DOE Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.

[e] Concentration of parameter exceeded Tennessee state water quality criteria. The state standards exceeded apply to protection of aquatic biota. For the protection of human health, the maximum contaminant levels for these compounds are as follows: copper, 1mg/L secondary maximum contaminant level; mercury, 0.002 mg/l maximum contaminant level; and zinc, 5 mg/l.

[f] Tennessee state water quality criteria.

[g] National Secondary Drinking Water Regulations (40 CFR 143).

[h] All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored concentration. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the environmental level and there is no significant impact from the facility.

Note: NA - not applicable.

Source: DOE 1993u; OR DEC 1991a; OR DOE 1991a; OR DOE 1992c.

**Surface Water Rights and Permits.** In Tennessee, the state's water rights laws are codified in the *Water Quality Control Act*. In effect, the water rights are similar to riparian rights in that the designated usages of a water body cannot be impaired. The only requirement to withdraw water from available supplies would be a U.S. Army Corps of Engineers permit to construct intake structures.

**Groundwater.** ORR is located in an area of sedimentary rocks of widely varying hydrological character. However, because of the topographic relief and a decrease in bedrock fracture density with depth, groundwater flow is restricted primarily to shallow depths and groundwater discharges primarily to nearby surface waters within ORR (ORNL 1992b). Depth to groundwater is generally 20 to 30 feet, but is as little as 5 feet in the area of Bear Creek Valley near Highway 95 (OR DOE 1992c).

Aquifers at ORR include a surficial soil and regolith unit and bedrock aquifers. The surficial aquifer consists of man-made fill, alluvium, and weathered bedrock. Bedrock aquifers occur in carbonates and low-yield sandstones, siltstones, and shales.

There are no Class I sole-source aquifers that lie beneath ORR. All aquifers are considered Class II aquifers (current potential sources of drinking water). Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one supply well exists on the Reservation; it provides a supplemental water supply to an aquatics laboratory during extended droughts.

Recharge occurs over most of the area but is most effective where overburdened soils are thin or permeable. In the area near Bear Creek Valley, recharge into the carbonate rocks is mainly along Chestnut Ridge. Groundwater generally flows from the recharge areas to the center of Bear Creek Valley and discharges into Bear Creek and its tributaries (OR DOE 1992c).

**Groundwater Quality.** Groundwater samples are collected quarterly from over 1,000 monitoring wells throughout ORR. Groundwater samples collected from the monitoring wells are analyzed for a standard suite of parameters and constituents, including trace metals, volatile organic compounds, radioactive materials, and pH (ORNL 1992b). Background groundwater quality at ORR is generally good in the near surface aquifer zones and poor in the bedrock aquifer at depths greater than 1,000 feet due to high total dissolved solids.

Groundwater in Bear Creek Valley near Y-12 has been contaminated by hazardous chemicals and radionuclides (mostly uranium) from weapons production process activities. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (OR DOE 1992c). The groundwater quality as indicated by groundwater contamination monitoring wells near the proposed TSS at ORR is summarized in table 4.4.2.4–2.

**Groundwater Availability, Use, and Rights.** Industrial and drinking water supplies in the area are primarily taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by the public water supply system. Most of the residential supply wells in the immediate area of ORR are south of the Clinch River (OR DOE 1992c). The State of Tennessee does not issue permits or allotments and does not regulate groundwater use.

#### 4.4.2.5 *Geology and Soils*

**Geology.** ORR lies in the Valley and Ridge province of east-central Tennessee. The topography consists of alternating valleys and ridges that have a northeast-southwest trend, with most ORR facilities occupying the valleys; Y-12 and the proposed TSS are in the Bear Creek Valley. Bear Creek Valley and the adjacent Pine and Chestnut Ridges are underlain by rocks composed of siltstone, silty limestone, and shale with some sandstone. The present topography of the valleys is the result of stream erosion of the softer shales and limestones; the ridges are underlain by the more resistant sandstones and dolomites.

ORR is cut by many inactive faults formed during the late Paleozoic Era. There is no evidence of capable faults in the immediate area of Oak Ridge within the definition of 10 CFR 100, Appendix A; the nearest are 300 miles west in the New Madrid fault zone (OR EG&G 1991a).

The Oak Ridge area lies at the boundary between Seismic Zones 1 and 2A, indicating that minor to

**TABLE 4.4.2.4–2.—*Groundwater Quality Monitoring at Oak Ridge Reservation***

| Parameter | Unit of Measure | Water Quality Criteria and Standard[a] | Existing Conditions (1991)[b] | | |
|---|---|---|---|---|---|
| | | | Well No. GW-655 | Well No. GW-683 | Well No. GW-685 |
| Alkalinity-$CO_3$ | mg/l | NA | <1 | <1 | <1 |
| Alkalinity-$HCO_3$ | mg/l | NA | 35 | 141 | 245 |
| Alpha (gross) | pCi/l | 15[c] | 1.77 | 12.60 | 1.35 |
| Aluminum | mg/l | 0.05-0.2[d] | 2.4 | 0.22 | 0.062 |
| Barium | mg/l | 2.0[c] | 0.21 | 0.083 | 0.091 |
| Beta (gross) | pCi/l | 50[e] | 1.59 | 27.40 | 6.68 |
| Boron | mg/l | NA | 0.016 | 0.063 | 0.054 |
| Calcium | mg/l | NA | 4.5 | 4.8 | 71 |
| Chloride | mg/l | 250[d] | <1 | 6.2 | 31 |
| Chromium | mg/l | 0.05[f] | 0.034 | <0.01 | 0.01 |
| Copper | mg/l | 1.3[c] | 0.012 | <0.004 | <0.004 |
| Fluoride | mg/l | 4.0[c] | 0.2 | 0.2 | 0.2 |
| Iron | mg/l | 0.3[d] | 4.6 | 0.26 | 0.29 |
| Lead | mg/l | 0.015[c] | 0.0096 | <0.004 | <0.004 |
| Magnesium | mg/l | NA | 6.4 | 14 | 20 |
| Manganese | mg/l | 0.05[d] | 0.075 | 0.011 | 0.086 |
| Nickel | mg/l | NA | <0.01 | <0.01 | <0.01 |
| Nitrate-N | mg/l | 10.0[c] | <0.2 | 4.4 | 2.74 |
| pH | pH units | 6.5-8.5[d] | 7.9 | 7.13 | 7.38 |
| Potassium | mg/l | NA | 2 | 2 | 1.9 |
| Sodium | mg/l | NA | 6 | 4.4 | 18 |
| Strontium | mg/l | NA | 0.022 | 0.079 | 0.099 |
| Sulfate | mg/l | 250[d] | 9.2 | 18.2 | 20 |
| Total dissolved solids | mg/l | 500[d] | 94 | 212 | 350 |
| Uranium | pCi/l | 20[g] | <0.001 | 0.032 | 0.002 |
| Vanadium | mg/l | NA | <0.005 | <0.005 | <0.005 |
| Zinc | mg/l | 5.0[d] | 0.027 | 0.0077 | 0.0091 |

[a] For comparison only.
[b] Well locations are shown on figure 4.4.2.4–1.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[f] Tennessee water quality standards.
[g] DOE Derived Concentrations for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective does equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guide.
Note: NA - not applicable.
Source: OR DEC 1991a; OR DOE 1992a.

moderate damage could occur as a result of earthquakes (figure 4.4.2.5–2). Since the New Madrid earthquakes of 1811–1812, at least 26 other earthquakes with a modified Mercalli intensity of III to VI have been felt in the Oak Ridge area; most of these have occurred in the Valley and Ridge province. The nearest seismic event occurred in 1930, 5 miles from ORR; it had an intensity of V at the site (OR EG&G 1991a).

There is no volcanic hazard at ORR. The area has not experienced volcanism within the last 230 million years. Therefore, future volcanism is not expected.

**Soils.** Bear Creek Valley lies on well to moderately well drained soils underlain by shale, siltstone, and sandstone. Developed portions of the valley are designated as urban land. Soil erosion from past land uses has ranged from slight to severe. Erosion potential is very high in those areas with slopes greater than 25 percent and which have been eroded in the past. Erosion potential is lowest in nearly flat-lying permeable soils that have a loamy texture (ORNL 1988b). Additionally, wind erosion is slight, and shrink-swell potential is low to moderate and the soils are acceptable for standard construction techniques.

#### 4.4.2.6 *Biotic Resources*

The following describes biotic resources at ORR including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area, the discussion focuses first on ORR as a whole and then on the proposed TSS. Scientific names of species identified in the text are presented in appendix C. Also presented in the appendix is a list of threatened and endangered species that may occur on the site or in the vicinity of ORR.

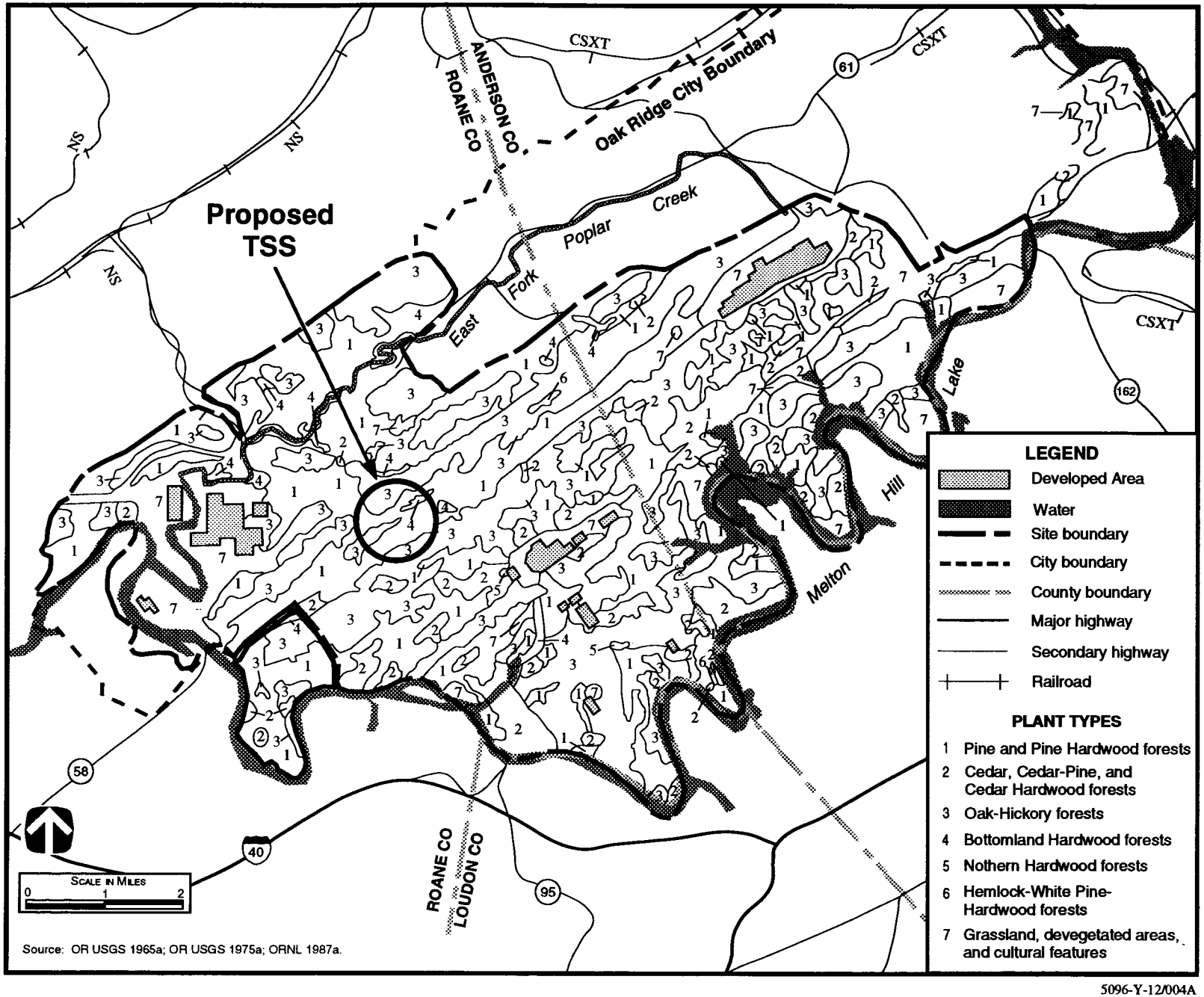
**Terrestrial Resources.** Plant communities at ORR are characteristic of the intermountain regions of central and southern Appalachia. Approximately 10 percent of ORR has been developed since it was withdrawn from public access; the remainder of the site has reverted to or been planted with natural vegetation (OR DOE 1989a). The vegetation of ORR has been categorized into seven plant communities (figure 4.4.2.6–1) (ORNL 1987a).

Pine and pine-hardwood forest is the most extensive plant community on ORR. Important species of this community type include loblolly pine, shortleaf pine, and Virginia pine (ORNL 1987a). Another abundant plant community is the oak-hickory forest, which is commonly found on ridges throughout ORR. Northern hardwood forest and hemlock-white pine-hardwood forest are the least common forest community types on ORR. Currently, forest resources of ORR are not managed for timber production (ORR 1992a:7), although in the past both cordwood and saw timber were produced (ORNL 1986b). Nine-hundred eighty-three species, subspecies, and varieties of plants have been identified on ORR (ORNL 1993a).

Animal species found on ORR include 26 species of amphibians, 33 species of reptiles, 169 species of birds, and 39 species of mammals (OR NERP nda). Animals commonly found on ORR include the American toad, eastern garter snake, Carolina chickadee, northern cardinal, white-footed mouse, and raccoon. Although the whitetail deer is the only species hunted onsite (OR DOE 1991c), other game animals are also present. Raptors, such as the northern harrier and great horned owl, and carnivores, such as the gray fox and mink, are ecologically important groups on ORR (ORNL 1981a). A variety of migratory birds has been found at ORR. Migratory birds, their nests and eggs, are protected by the *Migratory Bird Treaty Act.*

Vegetative communities in the area of the proposed TSS are typical of ORR as a whole, with pine and pine hardwood and oak-hickory forest being the predominant community types. Fauna of the proposed TSS would also be similar to that expected throughout ORR.

**Wetlands.** Wetlands on ORR have recently been evaluated based on National Wetland Inventory maps and field surveys of vegetation. Soils and hydrology were not specifically considered in this survey. Wetland surveys at ORR conducted since 1992 have used the U.S. Army Corps of Engineers methodology. This survey uses the three criteria of hydrophytic vegetation, hydric soils, and wetland hydrology. Based on this survey, wetlands on ORR include emergent, scrub/shrub, and forested wetlands associated with embayments of the Melton Hill and Watts Bar Reservoirs, riparian areas bordering major streams and their tributaries, old farm ponds, and groundwater seeps. Well-developed communities of emergent wetland plants in the shallow embayments of the two reservoirs typically intergrade into forested wetland plant communities, which extend upstream through riparian areas associated with streams and their tributaries. Old farm ponds on ORR vary in size and support diverse plant communities and fauna. Although most riparian wetlands on ORR are forested, areas within utility rights-of-way, such as those in Bear Creek and Melton Valleys, support emergent wetland vegetation (OR NERP 1991a).




Source: OR USGS 1965a; OR USGS 1975a; ORNL 1987a.

5096-Y-12/004A

FIGURE 4.4.2.6–1.—*Distribution of Plant Communities at Oak Ridge Reservation.*

Within the vicinity of the proposed TSS, most wetlands are forested, located in riparian areas bordering headwater tributaries to Bear Creek, Grassy Creek, and Ish Creek. Forested wetlands also occupy several acres in the floodplain of Bear Creek as it flows through this vicinity. Emergent wetlands are present where tributaries to Grassy Creek cross a power line paralleling Bear Creek Road.

Portions of the forested wetland in the Bear Creek floodplain located near the northern edge of the proposed TSS are designated as a National Environmental Research Park Reference Area and Natural Area. This wetland area is uncommon because it is not subject to the changing water levels from the Tennessee Valley Authority dams, and it has a deep, organic substrate combined with a diversity of herbaceous plants. The springs, seeps, and old streambeds create a variety of habitats. This wetland supports a state-listed endangered plant species. A portion of the Reference Area and the entire Natural Area have been designated as state Natural Areas (OR NERP 1993a).

**Aquatic Resources.** Aquatic habitat on or adjacent to ORR ranges from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams. Aquatic areas in ORR also include seasonal and intermittent streams. The ORR streams evaluated for this project include Bear Creek, Grassy Creek, and Ish Creek, as well as the Clinch River.

Sixty-four fish species have been collected on or adjacent to ORR. The minnow family has the largest number of species and is numerically dominant in most streams (ORNL 1988c). Fish species representative of the Clinch River in the vicinity of ORR are shad, herring, common carp, catfish, bluegill, crappie, and drum (ORNL 1981b). The most important fish species taken commercially in the ORR area are common carp and catfish. The recreational species consist of crappie, bass, sauger, sunfish, and catfish (OR DEC 1992e; OR WRA 1993a).

Fish species that have been recorded near the proposed TSS include 19 species in Bear Creek, 15 species in Grassy Creek, and 8 species in Ish Creek (OR DOE 1984a). Fish found in these streams include: blacknose dace, creek chub, shiner, Tennessee dace, banded sculpin, central stoneroller, bluntnose minnow, redbreast sunfish, and rock bass. Commercial and sport fishing are not permitted within ORR (OR DOE 1984a; ORNL 1988c; ORNL 1992c).

A National Environmental Research Park Aquatic Reference Area is located along Grassy Creek and its tributaries to the southwest of the proposed TSS. Grassy Creek has a diverse assemblage of invertebrates and fish species for a stream its size. ORR uses Grassy Creek as a reference area for studies of other streams affected by site development.

**Threatened and Endangered Species.** Eighty-eight Federal and state-listed threatened, endangered, and other special status species have been identified on and in the vicinity of ORR (appendix table C–4). Thirty of these species may occur on or near the proposed TSS (table 4.4.2.6–1). No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on ORR.

There are no Federal listed threatened and endangered species known to occur in the proposed TSS. East Fork Poplar Creek, north of the proposed TSS, contains suitable habitat for the Indiana bat. ORR lies within the geographic range of the gray bat but suitable caves for this species are not known to occur on or near the proposed TSS. Neither bat species was collected during a limited survey conducted in 1992 (OR TT 1993a). The peregrine falcon may occur in the area as a rare migrant or winter visitor. Hellbenders may occur in streams that drain the proposed TSS. Federal candidate species do not receive legal protection under the *Endangered Species Act*, but the USFWS recommends that impacts to these species be considered in project planning.

A number of state-listed threatened and endangered species are known to occur in the proposed TSS. The Cooper's and sharp-shinned hawks are resident forest-dwelling raptors (ORNL 1987b). The Cooper's hawk probably nests on ORR, and the sharp-shinned hawk has been observed nesting on ORR (ORR 1992a:3). A large population of pink lady's-slippers have been found within a National Environmental Research Park Reference Area

**TABLE 4.4.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Proposed Tritium Supply Site at Oak Ridge Reservation* [Page 1 of 2]**

| Species | Status[a] Federal | Status[a] State | Known or Potential Habitat/Location |
|---|---|---|---|
| **Mammals** | | | |
| Eastern woodrat | C2 | D | Rocky cliffs |
| Gray bat[b] | E | E | Caves, forage over water |
| Indiana bat[b] | E | E | Floodplain hardwood forest |
| Southeastern shrew | NL | D | Open fields and wood lots |
| **Birds** | | | |
| American peregrine falcon[b] | E | E | Rare migrant, winter visitor |
| Arctic peregrine falcon | T | E | Rare migrant, winter visitor |
| Bachman's sparrow | C2 | E | Open pine woods |
| Barn owl | NL | D | Woodlands, dense conifers (winter) |
| Bewick's wren | C2 | T | Thickets, underbrush |
| Black vulture[c] | NL | D | Entire Oak Ridge Reservation |
| Cooper's hawk[c] | NL | T | Woodland forest, uncommon permanent resident |
| Grasshopper sparrow | NL | T | Grassy, weedy fields |
| Northern harrier | NL | T | Rare migrant, winter visitor, forages in fields |
| Redheaded woodpecker | NL | D | Floodplain forest |
| Red-shouldered hawk[c] | NL | D | Woodland, floodplain forest |
| Sharp-shinned hawk[c] | NL | T | Woodland forest, rare permanent resident |
| **Reptiles** | | | |
| Northern pine snake | NL | T | Sandy pine woods, dry mountain ridges |
| Six-lined racerunner | NL | D | Open, well-drained areas |
| **Amphibians** | | | |
| Hellbender[c] | C2 | D | Rivers, streams with running water and ample shelter |
| Tennessee cave salamander | C2 | T | Caves with streams and pools in county |
| **Fish** | | | |
| Tennessee dace[c] | NL | D | Bear Creek and tributaries |
| **Plants** | | | |
| Canada (wild yellow) lily[c] | NL | T | Moist woods and edges in Natural Area just north and east of TSS |
| Fen orchid[c] | NL | E | Lower McNew Hollow, in Natural Area north of TSS |
| Ginseng[c] | NL | T | Rich woods, Bear Creek |
| Golden seal[c] | NL | T | Limestone, moist woods in Natural Area just northeast of TSS |
| Gravid sedge[c] | NL | S | Dry open soil |
| Michigan lily[c] | NL | T | Moist woods |
| Pink lady's-slipper[c] | NL | E | Pine Ridge area |

**TABLE 4.4.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Proposed Tritium Supply Site at Oak Ridge Reservation* [Page 2 of 2]**

| Species | Status[a] Federal | Status[a] State | Known or Potential Habitat/Location |
|---|---|---|---|
| **Plants** continued | | | |
| Purple fringeless orchid[c] | NL | T | Along small powerline near Bear Creek Road |
| Tuberculed rein-orchid[c] | NL | T | Shaded wetland along Bear Creek, in Natural Area north of NFS |

[a] Status code: C2 - candidate, Category 2 (possibly appropriate to list); D, - deemed in need of management; E - endangered; NL - not listed; S - sensitive; T - threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur on or near proposed TSS.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; OR FWS 1990a; OR FWS 1991a; OR FWS 1992a; OR NERP 1993a; ORNL 1981a; ORNL 1984b; ORNL 1991b; ORR 1992a:4.

located northeast of the proposed TSS. This population is expected to occur throughout the Pine Ridge area, which includes the proposed project site (ORNL 1992a). The tubercled rein-orchid occurs in two National Environmental Research Park Natural Areas, one located near the northern section of the proposed TSS along Bear Creek and the other extending from the eastern edge of the proposed TSS. The purple fringeless orchid and Canada lily also occur in the latter area. Ginseng is found in the western edge of the TSS. The fen orchid occurs in the Bear Creek/McNew Hollow floodplain within a Natural Area located to the northeast of the proposed TSS (OR NERP 1993a).

Several species listed by the state in need of management occur in the proposed TSS. The red-shouldered hawk and black vulture are both resident raptor species that nest on ORR, the latter near the proposed TSS (ORNL 1988c; ORR 1991a:7). The Tennessee dace is an inhabitant of Bear Creek and its tributaries. This stream system, which flows through the proposed TSS, is designated as a National Environmental Research Park Aquatic Natural Area. The habitat of this fish is protected by the state (OR DOE 1990a). Bear Creek is the site of life history studies of the Tennessee dace and may contain the greatest density of this species in the state. The Tennessee dace also occurs in several other streams designated as Aquatic Natural Areas, including Ish Creek and a number of tributaries of East Fork Poplar Creek (OR NERP 1993a).

### 4.4.2.7 *Cultural and Paleontological Resources*

**Prehistoric Resources.** More than 20 cultural resources surveys have been conducted on ORR. About 90 percent of ORR has received at least reconnaissance-level studies, however, less than 5 percent has been intensively surveyed. Most cultural resources studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, burial mounds, camps, quarries, chipping stations, limited activity locations, and shell scatters. Over 65 prehistoric sites have been recorded at ORR. At least 10 prehistoric sites may be considered potentially eligible for the NRHP; however, most of these sites have not yet been evaluated.

Only a reconnaissance-level survey has been conducted on portions of the proposed TSS. The survey found no prehistoric sites, however, additional prehistoric sites, mostly small camps and activity locations, may be identified in the unsurveyed portions of the TSS.

**Historic Resources.** Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR include both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, gravehouses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of foundations, roads, and trash scatters. Sixty-five pre-1942 cemeteries

were located within the original ORR (OR Robinson 1950a:130). Today there are 30 cemeteries within ORR since the size of the reservation has reduced. More than 240 historic resources have been recorded at ORR, and 20 of those sites may be considered potentially NRHP-eligible. Freels' cabin, two church structures, and two guard houses have been listed on the NRHP. The X-10 Reactor is listed on the register as a national landmark. Many other buildings and facilities at ORR are associated with the Manhattan Project and may be potentially eligible for the NRHP. Historic building surveys were completed during fiscal year 1994 at K-25 and Oak Ridge National Laboratory. Similar surveys are planned during fiscal year 1995 at Y-12.

A reconnaissance-level survey has been conducted on portions of the proposed TSS. Forty-five historic sites have been previously recorded; however, only four are considered potentially NRHP-eligible. Additional historic sites may be anticipated in the unsurveyed portions of the TSS.

**Native American Resources.** The Overhill Cherokee occupied portions of the Tennessee, Hiwassee, Clinch, and Little Tennessee River Valleys by the 1700's. Overhill Cherokee villages consisted of a large townhouse, a summer pavilion, and a plaza; residences had both summer and winter structures. Subsistence was based on hunting, gathering, and horticulture. The Cherokee were relocated to the Oklahoma territory in 1838; some Cherokee later returned to the area from Oklahoma. Resources that may be sensitive to Native American groups include prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas.

**Paleontological Resources.** The majority of geological units with surface exposures at ORR contain paleontological materials. All paleontological materials consist of invertebrate remains, and these assemblages have relatively low research potential.

#### 4.4.2.8 *Socioeconomics*

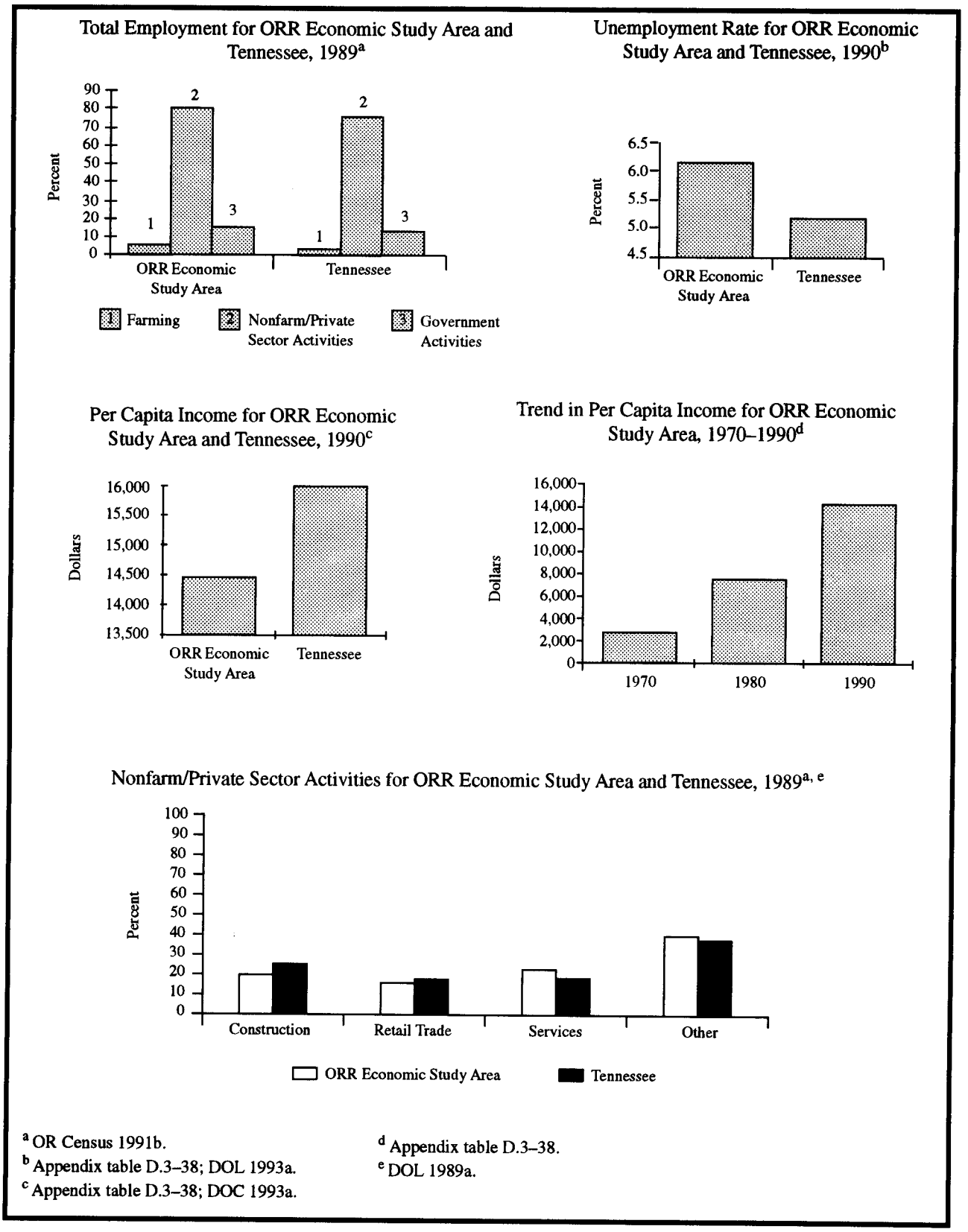
Socioeconomic characteristics addressed at ORR include employment and local economy, population, housing, public finance, and local transportation. Statistics for employment and local economy are based on the economic study area that encompasses 29 counties around ORR. The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for the remaining socioeconomic characteristics are based on the ROI, a 4-county area in which 95 percent of all ORR employees reside: Anderson County (35 percent), Knox County (37 percent), Loudon County (6 percent), and Roane County (17 percent). (See figure 4.4–1 for a map of counties and cities). Fiscal characteristics of the jurisdictions in the ROI are presented in the public finance section in appendix table D.3–47. The schools most likely to be affected by the proposed action include those funded by Anderson, Knox, Loudon, and Roane Counties and the cities of Clinton, Oak Ridge, Lenoir City, and Harriman. Assumptions, assessment methodologies, and supporting data are presented in appendix D.

**Employment and Local Economy.** Employment and local economy statistics for the ORR economic study area are given in appendix table D.3–38 and summarized in figure 4.4.2.8–1. Between 1970 and 1990, the civilian labor force in the economic study area increased 50 percent. The unemployment rate in the economic study area in 1990 was slightly higher than the rate for Tennessee. The 1990 per capita income in the economic study area was approximately 10 percent below the state.

As shown in figure 4.4.2.8–1, the percentage of total employment involving farming in the economic study area was slightly higher than the state. The percentage employed in governmental activities was approximately the same. Nonfarm private sector activities of manufacturing, retail trade, and services were similar in the economic study area and the state.

In 1990, ORR employed 15,273 persons (3.1 percent of the total economic study area employment), increasing from 14,257 persons in 1970. Historical and future employment of ORR and the distribution of ORR employees by place of residence in the ROI are presented in appendix tables D.2.1–1 and D.3–37, respectively.

**Population and Housing.** Population and housing distribution in the ROI is presented in appendix tables D.3–41, D.3–44 and summarized in figure 4.4.2.8–2. The percent increase in population in the ROI from 1970 to 1990 was similar to that of the state




[a] OR Census 1991b.
[b] Appendix table D.3–38; DOL 1993a.
[c] Appendix table D.3–38; DOC 1993a.
[d] Appendix table D.3–38.
[e] DOL 1989a.

**FIGURE 4.4.2.8–1.—*Economy for Oak Ridge Reservation Economic Study Area.***

except for the city of Clinton, which experienced an 87-percent increase. The percentage increase in housing units between 1970 and 1990 was similar to the percentage increase for the state with the exception of the city of Clinton (135-percent increase). Homeowner and rental vacancy rates in the ROI in 1990 were similar to those experienced by the state.

**Public Finance.** Financial characteristics of the local jurisdictions in the ROI that are most likely to be affected by the proposed action are presented in this section. The data reflect total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. Funding for schools in the ROI is provided by the county or city in which they are located. Major revenue and expenditure fund categories for counties and cities are presented in appendix table D.3–47. Figure 4.4.2.8–3 summarizes local governments revenues less its expenditures.

**Local Transportation.** Vehicular access to the Y-12 Plant is via Bear Creek Valley Road. State Routes 58, 62, 95, and 162 pass through ORR and are open to the general public (figure 4.4–1). Road segments providing access to Y-12 experience varying levels of traffic congestion. Traffic on State Route 162 generally experiences less traffic congestion than Bear Creek Valley Road and State Route 58, whereas traffic on State Routes 95 and 62 generally experience more traffic congestion.

Road reconstruction, widening, modification of interchanges, and new interchange construction projects are planned for segments of Bear Creek Valley Road, Scarboro Road, and State Routes 58, 62, and 95 (figure 4.4–1) (OR DOE 1991f; OR DOT 1992a; OR DOT 1992b).

The city of Oak Ridge has no public transportation service. Other modes of transportation within the ROI include railways and waterways. Railroad service in the ROI is provided by two main lines. A spur line serves Y-12 as well as the city of Oak Ridge. Waterborne transportation is potentially available via the Clinch River. The Clinch River waterway has rarely been used for DOE business and no designated port facilities exist for such purposes (USCOE 1991a).

The McGhee Tyson Regional Airport in the city of Knoxville, approximately 23 miles from ORR, supports regularly scheduled jet air passenger and cargo aircraft. Numerous private airports are located throughout the ROI (DOT 1991a).

### 4.4.2.9 *Radiation and Hazardous Chemical Environment*

The following provides a description of the radiation and hazardous chemical environment at ORR. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

**Radiation Environment.** Major sources of background radiation exposure to individuals in the vicinity of ORR are shown in table 4.4.2.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to ORR operations.

**TABLE 4.4.2.9–1.—*Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Oak Ridge Reservation Operations***

| Source | Committed Effective Dose Equivalent (mrem/yr) |
|---|---|
| **Natural Background Radiation**[a] | |
| Cosmic and cosmogenic radiation | 29 |
| External terrestrial radiation | 38 |
| Internal terrestrial radiation | 39 |
| Radon in homes (inhaled) | 200 |
| **Other Background Radiation**[b] | |
| Diagnostic X-rays and nuclear medicine | 53 |
| Weapons test fallout | <1 |
| Air travel | 1 |
| Consumer and industrial products | 10 |
| **Total** | 371 |

[a] From EPA 1981b. Value for radon is an average for the United States.
[b] NCRP 1987a.

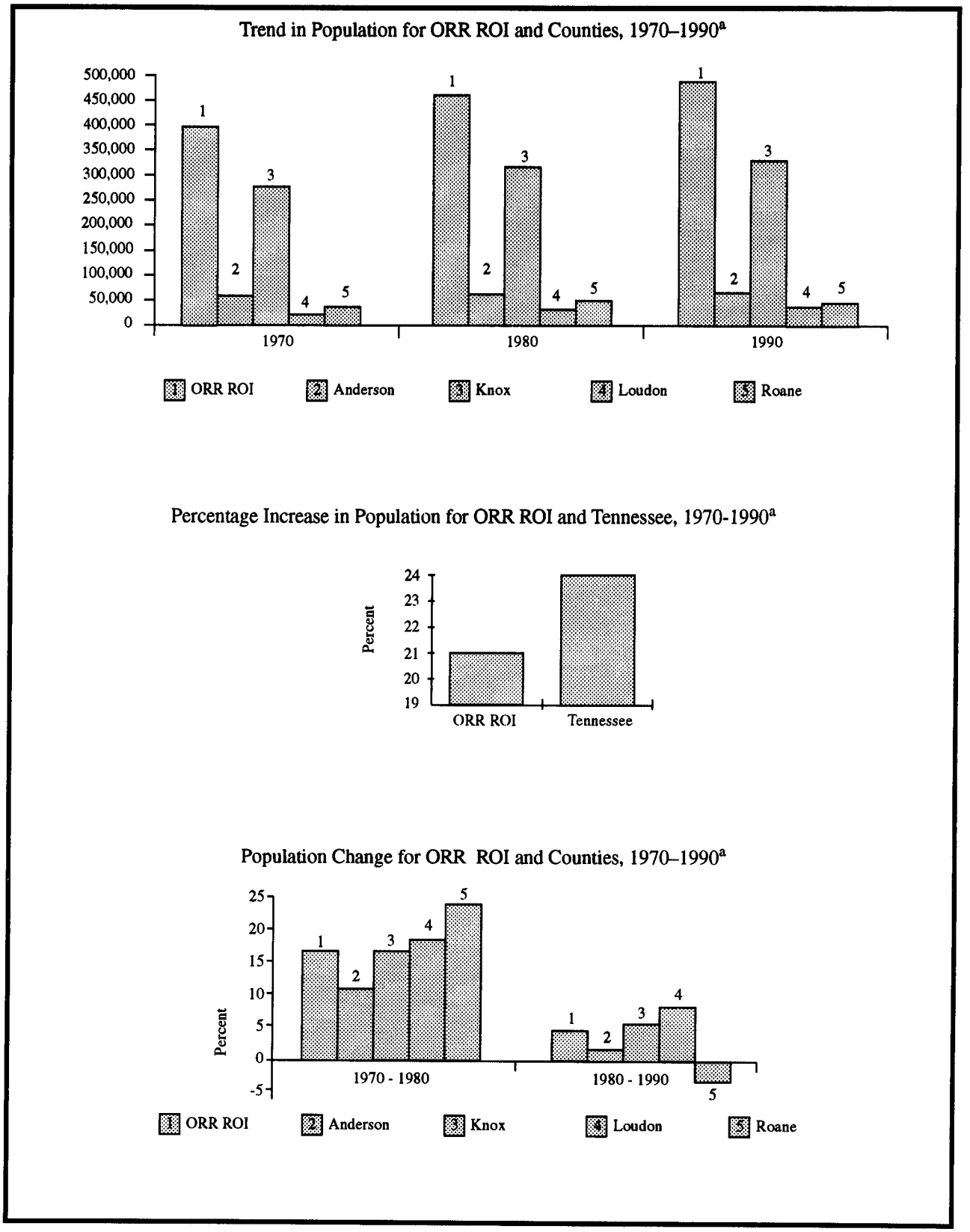
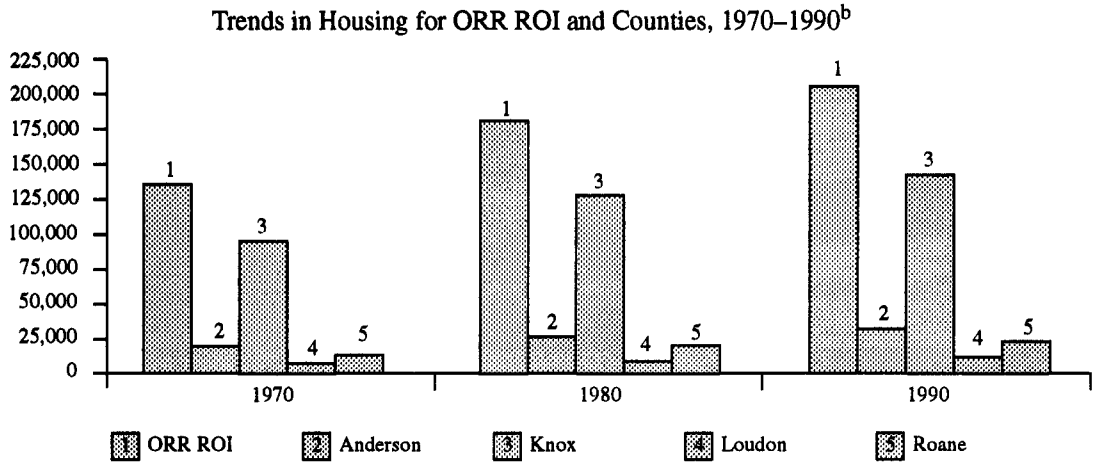
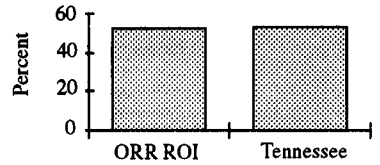
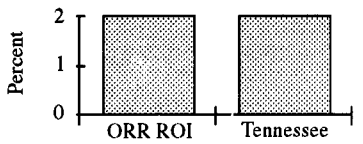
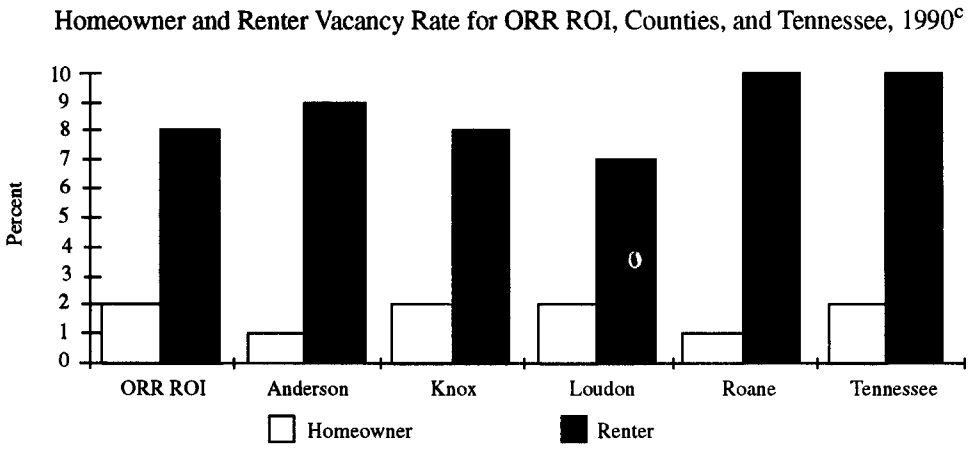



**FIGURE 4.4.2.8–2.—*Population and Housing for Oak Ridge Reservation Region-of-Influence* [Page 1 of 2].**



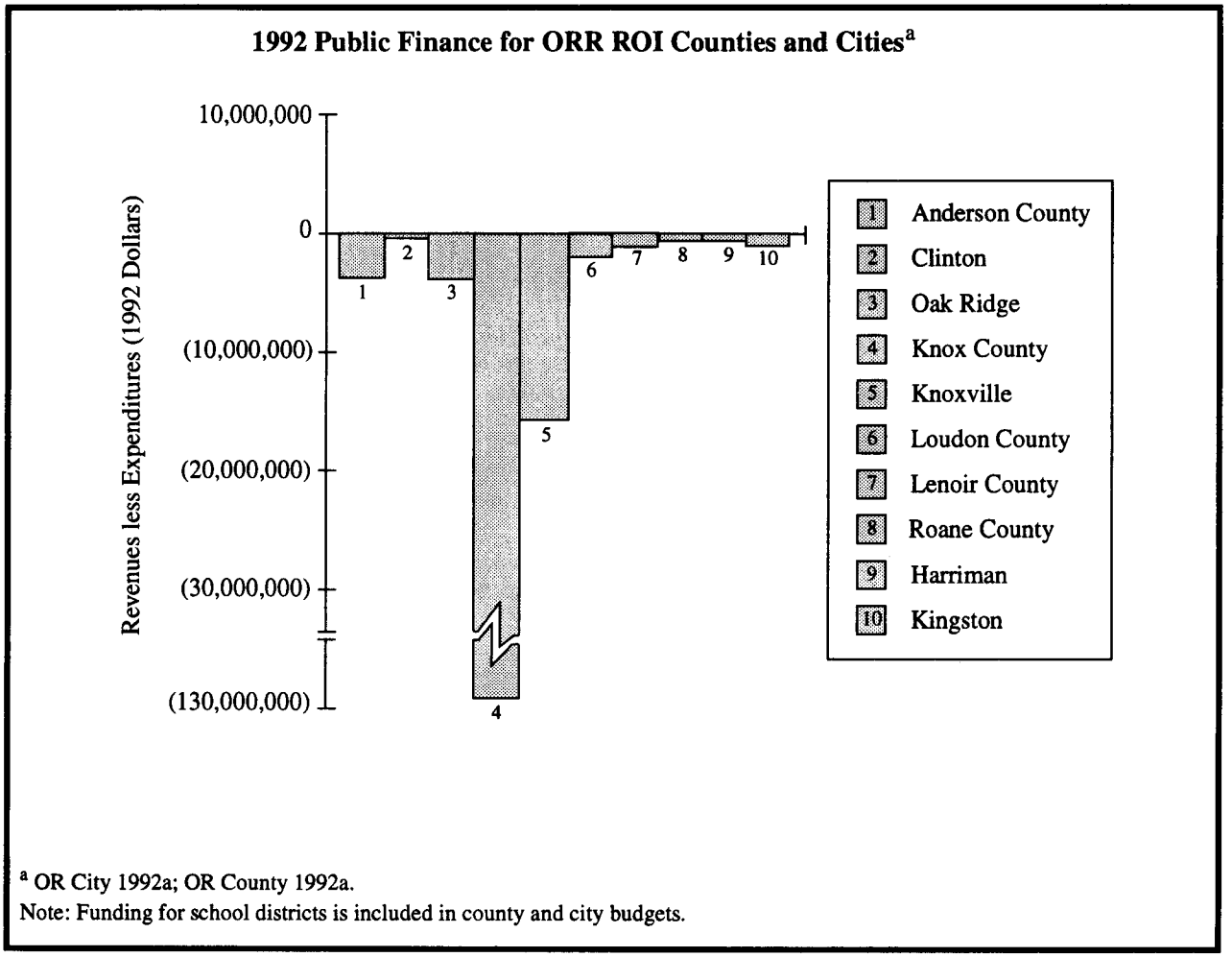




[a] Appendix table D.3–41.
[b] Appendix table D.3–44.
[c] Census 1972a; Census 1982a; OR Census 1991a.

**FIGURE 4.4.2.8–2.—*Population and Housing for Oak Ridge Reservation Region-of-Influence* [Page 2 of 2].**




[a] OR City 1992a; OR County 1992a.
Note: Funding for school districts is included in county and city budgets.

**FIGURE 4.4.2.8–3.—*1992 Local Government Public Finance for Oak Ridge Reservation Region-of-Influence.***

Releases of radionuclides to the environment from ORR operations provide another source of radiation exposure to individuals in the vicinity of ORR. The radionuclides and quantities released from operations in 1992 are listed in the *Oak Ridge Reservation Environmental Report for 1992* (ES/ESH-31/V1). The doses to the public resulting from these releases and direct radiation are presented in table 4.4.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1992 report were used in the development of the reference environment (No Action) radiological releases at ORR in the year 2010 (section 4.4.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (appendix section E.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from ORR operations in 1992 is estimated to be approximately $8.5 \times 10^{-6}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of ORR operations is less than 9 chances in 1 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Approximately $2.2 \times 10^{-2}$ excess fatal cancers were estimated from normal operations in 1992 to the population living within 50 miles of ORR. To place this number into perspective, it can be compared with the numbers of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a). Based on this national rate, the number of fatal cancers from all causes expected to occur during 1992 was 1,760 for

**TABLE 4.4.2.9–2.—*Doses to the General Public from Normal Operation at Nevada Test Site, 1992 (committed effective dose equivalent)***

| Affected Environment[a] | Atmospheric Releases | | Liquid Releases | | Total | |
|---|---|---|---|---|---|---|
| | Standard[b] | Actual | Standard[b] | Actual | Standard[b] | Actual |
| Maximally exposed individual (mrem) | 10 | 1.4 | 4 | 0.62 | 100 | 17.0 |
| Population within 50 miles[c] (person-rem) | None | 43 | None | 1.0 | 100 | 44.0 |
| Average individual within 50 miles[d] (mrem) | None | 0.049 | None | $1.1 \times 10^{-3}$ | None | 0.050 |

[a] From DOE 1993a.

[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834. If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[c] In 1992, this population was approximately 880,000.

[d] Obtained by dividing the population dose by the number of people living within 50 miles of the site.

the population living within 50 miles of ORR. This number of expected fatal cancers is much higher than the estimated $2.2 \times 10^{-2}$ fatal cancers that could result from ORR operations in 1992.

Workers at ORR receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.4.2.9–3 presents the average, maximum, and total occupational doses to ORR workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (appendix section E.2), the number of excess fatal cancers to ORR workers from operations in 1992 is estimated to be 0.027.

**TABLE 4.4.2.9–3.—*Doses to the Worker Onsite from Normal Operation at Nevada Test Site, 1992 (committed effective dose equivalent)***

| Affected Environment[a] | Onsite Releases and Direct Radiation | |
|---|---|---|
| | Standard[b] | Actual |
| Average worker (mrem) | None | 4.0 |
| Maximally exposed worker (mrem) | 5,000 | 2,000 |
| Total workers (person-rem) | None | 68 |

[a] From DOE 1993a.

[b] From 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Oak Ridge Reservation Environmental Report for 1992* (ES/ESH-31/V1). The concentrations of radioactivity in various environmental media (e.g., air, water, soil) in the site region (onsite and offsite) are also presented in the same report. ORR operations contribute small amounts of radioactivity to these media.

**Chemical Environment.** The background chemical environment important to human health consists of: the atmosphere, which may contain toxic chemicals that can be inhaled; drinking water, which may contain toxic chemicals that can be ingested; and other environmental media with which people may come in contact; e.g., surface waters during swimming, soil through direct contact, or via the food pathway. The baseline data for assessing potential health impacts from the chemical environment are those presented in previous sections of this PEIS, particularly sections 4.4.2.3 and 4.4.2.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (e.g., air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information and

inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing pollutants released to the atmosphere by ORR operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous/toxic air pollutants and their applicable standards are presented in section 4.4.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix section E.3.

Health impacts to ORR workers during normal operations may include those from: inhalation of the workplace atmosphere, drinking ORR potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. ORR workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 3790.1B) ensure that conditions in the work place are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at ORR are expected to be substantially better than required by the standards.

**Health Effects Studies.** Two epidemiologic studies were conducted to determine whether the Oak Ridge National Laboratory facility contributed to any excess cancers in the communities surrounding the facility. One study found no excess cancer mortality in the population living in counties surrounding Oak Ridge National Laboratory when compared to the control populations located in other nearby counties and elsewhere in the United States. The other found slight excess cancer incidences of several types in the counties near Oak Ridge National Laboratory, but none of the excess risks were statistically significant. More epidemiologic studies have been conducted to assess the health effects of the population working at ORR than at any other site reviewed for this PEIS. Excess cancer mortalities have been reported and linked to specific job categories, age, and length of employment as well as to the levels of exposure to radiation. For a more detailed description of the studies reviewed and the findings, refer to appendix section E.4.4.

**Accident History.** There have been no accidents with a measurable impact on offsite population during nearly 50 years of Y-12 operations at ORR. The most noteworthy accident in Y-12 history was the 1958 criticality accident. The impact from this accident resulted in temporary radiation sickness for a few ORR employees. In 1989, there was a one-time accidental release of xylene into the ORR sewer system with no adverse offsite impacts. Accidental releases of anhydrous hydrogen fluoride occurred in 1986, 1988, and 1992, with little onsite and negligible offsite impacts. The hydrogen fluoride system where these accidents occurred is being modified to reduce the probability of future releases and to minimize the potential consequences if a release does occur (ORR 1992a:6).

In the event of an accident, each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. Section 4.1.9 provides a description of DOE's emergency preparedness program.

DOE has overall responsibility for emergency planning and operations at ORR. However, DOE has delegated primary authority for event response to the operating contractor. Although the contractor's primary response is onsite, it does provide offsite assistance if requested under the terms of existing mutual aid agreements. If a hazardous materials event with offsite impacts occurs at a DOE ORR facility, elected officials and local governments are

responsible for the state's response efforts. The Governor's Executive Order No. 4 established the Tennessee Emergency Management Agency as the agency responsible for coordinating state emergency services. When a hazardous materials event occurring at DOE facilities is beyond the capability of local government and assistance is requested, the Tennessee Emergency Management Agency Director may direct state agencies to provide assistance to the local governments. To accomplish this task and ensure prompt initiation of emergency response actions, the Director may cause the State Emergency Operations Center and Field Coordination Center to be activated. City or county officials may activate local emergency operations centers in accordance with existing emergency plans.

#### 4.4.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for ORR. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.3. Tables 4.4.2.10–1 (Y-12), 4.4.2.10–2 (Oak Ridge National Laboratory), and 4.4.2.10–3 (K-25) present a summary of waste management at ORR for 1992.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

EPA placed ORR on the NPL on December 21, 1989. DOE, EPA Region IV, and the Tennessee Department of Environment and Conservation completed a Federal Facility Agreement effective January 1, 1992. This agreement coordinates future assessments and remedial activities at ORR under CERCLA with existing actions being conducted under RCRA and applicable state laws, minimizes duplication, expedites response actions, and achieves a comprehensive remediation of the site.

ORR generates and manages spent nuclear fuel and the following waste categories: TRU, LLW, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

**Spent Nuclear Fuel.** ORR generates and manages a small quantity of spent nuclear fuel. The only operating reactor is the Oak Ridge National Laboratory High-Flux Isotope Reactor, which is used to produce isotopes for medical and industrial applications, neutron scattering experiments, and various materials irradiation experiments. ORR has also received some offsite shipments of reactor irradiated nuclear material. Most of the fuel and irradiated nuclear material is stored in numerous buildings and hot cells at Oak Ridge National Laboratory and one building at Y-12. Some of the fuel still remains in the core of the inactive research reactors. Irradiated fuel and its associated fission products are stored in dry wells at Oak Ridge National Laboratory in Solid Waste Storage Area-5N. A small amount of irradiated spent nuclear fuel is stored in wells and trenches in Solid Waste Storage Areas-5S and -6. The interim management of the spent nuclear fuel (pending the availability of a geologic repository) will be in accordance with the ROD of the *DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs EIS* which DOE has published in draft form.

**High-Level Waste.** ORR does not generate or manage HLW.

**Transuranic Waste.** Oak Ridge National Laboratory is the only generator of TRU waste at ORR. Solid TRU waste consisting of filters, paper, metals, and other items was generated at Oak Ridge National Laboratory through laboratory, pilot plant, and reactor operations in 1992. This includes both contact-handled and remote-handled TRU waste contaminated with lead and, in some cases, mercury. Contact-handled waste is TRU waste that contains mainly plutonium, which emits alpha particles and low-energy photons. The packaging is designed to provide sufficient containment and shielding to minimize personnel exposure problems. Remote-handled TRU waste contains activation materials and

TABLE 4.4.2.10–1.—*Current Spent Nuclear Fuel and Waste Management at Y-12 Plant* [Page 1 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | NA | NA | Storage vaults[a] | 0.02[b] | None | NA |
| **Low-Level** | | | | | | | |
| Liquid | 740 (148,000 gal) | Settlement and filtration | 20,800[c] (4,200,000 GPY) | Stored onsite | None | NA | NA |
| Solid | 7,700 | Compaction/ incineration | 62,000[d] | Stored onsite at Y-12 or K-25 | 5,710[e] | Onsite (K-25) | NA |
| **Mixed Low-Level** | | | | | | | |
| Liquid | 2,120 (428,000 gal) | Settlement and filtration | 5,800[f] (1,200,000 GPY) | Tanks | 810[g] (162,600 gal) | NA | NA |
| Solid | 740 | None | NA | Staged for shipment | 2,200[h] | None - offsite to NTS pending | NA |
| **Hazardous** | | | | | | | |
| Liquid | 4,850 (978,000 gal) | Settlement and filtration | 273,000[i] (55,000,000 GPY) | Tanks | 1,320[j] (267,000 gal) | Offsite | NA |
| Solid | 1,100[k] | None | NA | Staged for shipment | 7,800 | Offsite | NA |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 3,200 $yd^3$/day (650,000 GPY) | Offsite[l] | 6,940 $yd^3$/day (1,400,000 GPD) | None | NA | Offsite | NA |
| Solid | 63,600[m] | None | NA | None | NA | Landfill (onsite) | 640,000[n] |

TABLE 4.4.2.10–1.—*Current Spent Nuclear Fuel and Waste Management at Y-12 Plant* [Page 2 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | 191,000[o] (38,500,000 gal) | Evaporation and incineration | 208,000[p] (41,900,000 GPY) | None | NA | Offsite-NPDES outfall | NA |
| Solid | 2,370[q] | None | NA | None | NA | Landfill VI and VII (onsite)[r] | 1,700,000 |

[a] Building 9720-5.
[b] Based on conversion factor of 13,700 kg/$yd^3$. The size of all fuel-elements was assumed to be the same and the Bulk Shielding Reactor pool was assumed to be 80 percent full, while the High Flux Isotope Reactor was 40 percent full. The Tower Shielding Reactor pool is already full. Thus, the available capacity of spent fuel pools was determined to be 214 kg.
[c] West End Treatment Facility and Central Pollution Control Facility.
[d] Waste Fuel Preparation Facility.
[e] Includes the Classified Waste Storage Facility and the Depleted Uranium Oxide Storage Vaults.
[f] Includes Biodentification Facility, Cyanide Treatment Facility, and Groundwater Treatment Facility. The West End Treatment Facility, the Plating Rinsewater Treatment Facility, and the Central Pollution Control Facility can process mixed waste and LLW.
[g] OD9, OD10, and Waste Storage Facility.
[h] RCRA and PCB Container Storage Area (9720-58), Container Storage Facility (Bldg. 9720-12), PCB Drum Storage Facility (9407-7), and the Solid Storage Facility. Does not include Y-12 Salvage Yard.
[i] Plating Rinsewater Treatment Facility and Stream Plant Wastewater Treatment Facility.
[j] Liquid Organic Waste Storage Facility OD3, Bldg. 9418-9, OD9, and Liquid Storage Facility.
[k] Currently, all RCRA-hazardous wastes are stored at Y-12 or K-25 awaiting further disposal.
[l] Oak Ridge Sewage Treatment Plant.
[m] Includes construction/demolition spoil, fly ash and classified waste.
[n] New sanitary landfill to open 1994. Current landfill is almost full.
[o] Includes wastewater treated at the Steam Plant Wastewater Treatment Facility (37,800,000 gal) and Plating Rinsewater Treatment Facility (375,000 gal).
[p] Approximate Central Pollution Control Facility, West End Treatment Facility, and Steam Plant Wastewater Treatment Facility NPDES permit annual discharge volume limits for East Fork Poplar Creek.
[q] Scrap metal.
[r] Serves all three sites and will be used only for construction debris.
Source: DOE 1993a; DOE 1993j; DOE 1993s; DOE 1993t;DOE 1994c OR DOE 1992c; OR DOE 1993a; OR MMES 1993f; ORR 1993a:4; ORR 1993a:5.

TABLE 4.4.2.10–2.—*Current Spent Nuclear Fuel and Waste Management at Oak Ridge National Laboratory* [Page 1 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | 0.008[a] | None | NA | Pools | 0.04[b] | None | NA |
| **Transuranic (Solid)** | | | | | | | |
| Contact handled | 14 | None | NA | Staged for shipment | 800 | None, WIPP in future | NA |
| Remote handled | 5 | None | NA | Staged for shipment | 290 | None, WIPP in future | NA |
| **Low-Level** | | | | | | | |
| Liquid | 1,970 (398,000 gal) | Ion exchange, decantation, stabilization, evaporation | 340,000[c] (68,500,000 GPY) | Stored onsite | 750 (150,000 gal) | NA | NA |
| Solid | 510[d] | Compaction | 14,800 | Stored onsite | 42,900[e] | Onsite | NA |
| **Mixed Low-Level** | | | | | | | |
| Liquid | None | Included in low-level waste | Included in low-level waste | Tanks | 770 (155,000 gal) | NA | NA |
| Solid | 160[f] | Planned | Planned | Staged for shipment | 110[g] | None, offsite to NTS pending | NA |
| **Hazardous** | | | | | | | |
| Liquid | 9 (1,850 gal) | Neutralization/ sedimentation and evaporation | 261,000[h] (53,000,000 GPY) | None | NA | Offsite | NA |
| Solid | 49[i] | None[j] | NA | Staged for shipment | 120[k] | Incineration (K-25)/offsite disposal Planned - onsite disposal | Planned |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 467,000[l] (94,200,000 gal) | Biological degradation | 542,000[m] (109,300,000 GPY) | None | NA | NPDES outfall | NA |
| Solid | 9,500[l] | None | NA | None | NA | Y-12 landfill | Included in Y-12 table 4.4.2.10–1 |

TABLE 4.4.2.10–2.—*Current Spent Nuclear Fuel and Waste Management at Oak Ridge National Laboratory* [Page 2 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | 783,000[n] (157,000,000 gal) | Evaporation and Incineration | 2,000,000[o] (403,000,000 GPY) | None | NA | Offsite | NA |
| Solid | 40[p] | None | NA | None | NA | Y-12 landfill and SWSA 6 burial | Included in sanitary |

[a] The HFIR research reactor generates 12 cores per year (9.4 kg U-235 per core). Same assumption as in table 4.4.2.10–1.

[b] Same assumptions as in table 4.4.2.10-1. Includes 600 kg of available spent fuel capacity at the HFLR pool (40 percent full) and 2 kg available capacity at the Bulk Shielding Reactor Pool (80 percent full).

[c] Process Waste Treatment Plant, Melton Valley Low-Level Waste Immobilization Facilities and Liquid Low-Level Waste Evaporation Facility.

[d] Includes scrap metal and sludge from Sanitary Waste Treatment Plant.

[e] Solid Waste Storage Area 6.

[f] Includes TSCA-regulated mixed LLW and radioactive asbestos. No RCRA- or state-regulated mixed LLW was generated in 1992.

[g] Mixed Waste Drum Storage Pads (Bldg. 7507W Part A permit - 22,000 gal).

[h] Nonradiological Wastewater Treatment Plant (Approximate capacity is 300 gpm).

[i] Includes PCB and asbestos.

[j] The Chemical Detonation Facility treats small amounts of hazardous water that would be dangerous to transport offsite. Explosives such as aged picric acid are detonated in this facility.

[k] Hazardous Waste Storage Facility (Bldg. 7652 Part B permit - 15,125 gal and Bldg. 7507 Part A permit - 8,250 gal).

[l] 1991 Generation Rate.

[m] Sanitary Waste Treatment Facility design capacity.

[n] Includes 374,000 $yd^3$ from Process Waste Treatment Facility and steamplant blowdown (1991 generation rate).

[o] NPDES discharge limit for ORNL Waste Water Treatment Facility.

[p] Scrap metal estimate not available (1991 generation rate).

Source: DOE 1992f; DOE 1993a; DOE 1993r; DOE 1993s; DOE 1993t; DOE 1994c OR DOE 1992c; OR DOE 1993a; OR DOE 1993b; OR MMES 1993d; ORR 1993a:4; ORR 1993a:6.

TABLE 4.4.2.10–3.—*Current Waste Management at K-25 Site* [Page 1 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity |
|---|---|---|---|---|---|---|---|
| **Low-level** | | | | | | | |
| Liquid | Included in Hazardous Liquid | Settlement and Filtration | 1,860[a] (375,000 GPY) | None | NA | NA | NA |
| Solid | 3,100[b] | Compaction/ smelting | Offsite | Stored onsite | Included in solid mixed low-level[c] | Planned onsite-nonmetallic Planned offsite-metallic | Planned |
| **Mixed Low-Level** | | | | | | | |
| Liquid | 1,500 (302,000 gal) | Settlement and filtration/ incineration | 452,000[d] (91,000,000 GPY) | Stored onsite | 127,000[e] (26,000,000 gal) | NA | NA |
| Solid | 11[f] | Planned | Planned[g] | Stored onsite | 157,000[h] | None | NA |
| **Hazardous** | | | | | | | |
| Liquid | 80,000[i] (16,000,000 gal) | Neutralization/ precipitation | 82,000[j] (16,600,000 GPY) | Stored for processing | NA | Planned offsite | NA |
| Solid | 900[k] | Compaction for non-RCRA/TSCA and incineration | 2,100[l] | Staged for shipment | Included in solid mixed low-level | Planned offsite | NA |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 844,000[m] (170,000,000 gal) | Neutralization/ precipitation | 1,100,000 - sewage[n] (219,000,000 GPY) 95,200 - industrial[o] (19,200,000 GPY) | None | NA | NPDES outfall | NA |
| Solid | 11,700[m] | None | NA | None | NA | Oak Ridge Landfill (offsite) | NA |

TABLE 4.4.2.10–3.—*Current Waste Management at K-25 Site* [Page 2 of 2]

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3/yr$) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | 3[m] | Included in sanitary | Included in sanitary | None | NA | Included in sanitary | NA |
| Solid | 5,600[p] | None | NA | Stockpiled at scrap yard | Unspecified capacity | Y-12 landfill and metal sold to public | Included in Y-12 table 4.4.2.10–1 |

[a] TSCA Incinerator (K-1435). Also treats mixed waste.
[b] May include some PCB-tainted waste.
[c] Does not include 6.9-acre scrap metal storage site.
[d] Central Neutralization Facility normal operating capacity.
[e] Includes current permitted container (solid/sludges/liquid wastes) and tank (liquids) storage capacity.
[f] Includes contaminated asbestos/beryllium oxide (BeO) and may include some PCB-tainted waste.
[g] Sludge Fixation Facility may be used after engineering problems are solved.
[h] Total current permitted waste pile unit storage capacity.
[i] Hydrogen softener blowdown from the steam plant and TSCA Incinerator wastewater.
[j] Amount of hazardous liquid waste treated in 1992. Some may also be included in mixed waste treatment capacity.
[k] Uncontaminated asbestos/BeO and PCB.
[l] Amount of hazardous (RCRA/TSCA) solid waste treated in 1992.
[m] 1991 generation rates.
[n] Sewage treatment plant capacity.
[o] Nonhazardous waste section of the Central Neutralization Facility. May be part of liquid mixed waste treatment capacity.
[p] Includes construction/demolition spoil and scrap metal (1991 generation rates).
Source: DOE 1993a; DOE 1993h; DOE 1994c;OR DOE 1992c; OR DOE 1993a; OR DOE 1993b; ORNL 1993a; ORR 1993a:4.

fission products that decay and emit beta and gamma radiation on the surface of the packaging that exceeds 200 mrem/hr.

As of December 31, 1992, approximately 1,400 $yd^3$ of TRU wastes were in retrievable drum or concrete cask storage. The amount of remote-handled waste was about 1,500 $yd^3$ (DOE 1994c:89). Current activities center around certification of contact-handled waste, planning/designing of a repackaging and certification facility for remote-handled wastes, and planning for shipment of wastes to the WIPP or another suitable repository which can provide for the disposal of TRU wastes pursuant to the provisions of 40 CFR 191.

**Low-Level Waste.** Solid LLW consisting primarily of radioactively-contaminated construction debris, wood, paper, asbestos, trapping media, process equipment, and radionuclides removed from liquid and airborne discharges is generated at ORR. Currently, solid LLW is being stored at K-25 and Y-12 for future disposal. Contaminated scrap metal is stored above ground at the K-770 scrap metal facility and the Y-12 old salvage yard until further disposal methods are evaluated. As of 1992, the amount of LLW buried at ORR was approximately 577,000 $yd^3$ (DOE 1994c:121).

The primary generator of radioactively-contaminated liquid waste is the K-1435 TSCA Incinerator from the wet scrubber blowdown. This waste is currently being treated at the Central Neutralization Facility, which provides pH adjustment and chemical precipitation. Treated effluents are discharged through an NPDES outfall. The contaminated sludges are stored above ground at K-25.

The Energy Systems Waste Management Organization has been established and assigned the responsibility to design, construct, and operate all new LLW disposal facilities for ORR. This organization is located at K-25. The new LLW disposal facilities will serve waste generators from all three DOE facilities on ORR. The Low-Level Waste Disposal Facilities project will provide new disposal facilities at a new centralized location of ORR for LLW, and capacity for up to 40 years at current generation rates. The facility will be able to handle tritium wastes. The disposal facility will utilize state-of-the-art disposal technologies for Below Regulatory Concern/Class L-I wastes and for Class L-II wastes. The limits for tritium waste are $5.6 \times 10^5$ $Ci/yd^3$ for Class L-I wastes and $1.2 \times 10^6$ $Ci/yd^3$ for Class L-II wastes. Class L-I waste is LLW that is suitable for disposal using sanitary/industrial landfill disposal technology and will not expose any member of the public to an effective dose equivalent of more than 10 mrem per year at the time of disposal. Class L-II waste is LLW primarily containing fission product radionuclides with half-lives of 30 years or less that is suitable for disposal in engineered facilities designed to isolate the waste from the environment and the public for a period of time sufficient to allow for the decay of radionuclides to such a level that any member of the public will not be exposed to an effective dose equivalent of more than 10 mrem per year (OR DOE 1992b:9-7). As currently scheduled, the Class L-II facility, for wastes contaminated with very low concentrations of long half-life radionuclides, is expected to be operational in 1998. DOE has indefinitely postponed construction of the Class L-I facility for wastes contaminated with low concentrations of predominantly short half-life radionuclides. The Federal Facility Agreement has specific requirements concerning LLW tank systems.

**Mixed Low-Level Waste**. RCRA mixed, radioactive land disposal restricted waste (including some nonradiological classified land ban waste) has been stored in some areas at K-25. Because storage of these wastes is in violation of RCRA, ORR entered into a Federal Facility Compliance Agreement for RCRA Land Disposal Restriction wastes with EPA on June 12, 1992. This Federal Facility Compliance Agreement recognizes that DOE will continue to generate and store such mixed wastes subject to land disposal restrictions. The terms of this agreement are presently being reviewed and will be renegotiated pursuant to the requirements of the *Federal Facility Compliance Act*. This compliance agreement will form the basis for the site-specific treatment plan required by the *Federal Facility Compliance Act* of 1992.

Sludges contaminated with low-level radioactivity are generated by settling and scrubbing operations and in the past were stored in K-1407-B and 1407-C ponds at K-25. Sludges have been removed from these ponds and a portion have been fixed in concrete at the K-1419 Sludge Treatment Facility and stored above ground at the K-1417 Casting and Storage

Yard. These materials are considered mixed waste and a delisting petition has been submitted to EPA. Disposition of this waste is pending a determination of this petition. Mixed waste sludges are also generated at Y-12 in the treatment of nitrate waste from purification/recycling of uranium and in the treatment of plating shop waste.

The K-25 TSCA incinerator has a design capacity to incinerate 2,000 lb/hr of mixed liquid waste and up to 1,000 lb/hr of solids and sludge (200 lb/hr maximum sludge content). DOE guidance currently does not allow incineration of solids/sludges. Because of permit limits (TSCA, RCRA, State of Tennessee), the incinerator is not running at full capacity. It is currently incinerating approximately 3,000,000 lb/yr (ORR 1993a:2).

Uranium-contaminated PCB wastes (i.e., mixed wastes) are being stored in excess of the 1-year limit imposed by TSCA because of the lack of treatment and disposal capacities. DOE and EPA have signed a Federal Facility Compliance Agreement, effective February 20, 1992, to bring the facility into compliance with TSCA regulations for use, storage, and disposal of PCBs. It also addressed the approximately 10,000 pieces of nonradioactive PCB-containing dielectric equipment associated with the shutdown of diffusion plant operations.

**Hazardous Waste**. RCRA-regulated and PCB wastes are generated by ORR in laboratory research, electroplating operations, painting operations, descaling, demineralizer regeneration, and photographic processes. Certain other wastes (e.g., spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport and contain no DOE-added radioactivity are shipped offsite to RCRA-permitted commercial treatment/disposal facilities. Small amounts of reactive chemical explosives that would be dangerous to transport offsite, such as aged picric acid are processed onsite in the Chemical Detonation Facility at Oak Ridge National Laboratory.

The majority of the Y-12 hazardous waste treatment, storage, and disposal units are currently operating in accordance with RCRA interim status requirements. Y-12 has submitted a RCRA Part B Permit application to the state for all hazardous waste treatment storage and disposal facilities. These applications are presently under review with the Tennessee Department of Environment and Conservation and the units are awaiting issuance of final RCRA operating permits. These permits will cover more than 200 RCRA waste streams, 48 90-day waste accumulation areas, and 49 underground tanks.

**Nonhazardous Waste.** Nonhazardous wastes are generated from ORR maintenance and utilities. For example, the steam plant produces nonhazardous sludge. Scrap metals are discarded from maintenance and renovation activities and are recycled when appropriate. Construction and demolition projects also produce nonhazardous industrial wastes. All nonradioactive medical wastes are autoclaved to render them noninfectious and are sent to the Y-12 Sanitary Landfill. A new landfill became operational in March 1994. Remedial action projects also produce wastes requiring proper management. The State of Tennessee permitted landfill receives nonhazardous industrial materials such as fly ash and construction debris. Asbestos and general refuse are managed in the Y-12 Sanitary Landfill.

Groundwater monitoring at five of seven land-based waste disposal sites at Y-12 have detected volatile organic compounds, nitrates, heavy metals, and radioactivity levels that exceed applicable standards. Additional monitoring wells and continued monitoring is required to define precise contaminant plumes.

### 4.4.3 Environmental Impacts

This section describes the environmental impacts of constructing and operating the various tritium supply technologies and recycling facilities at ORR described in section 4.4.1. It begins by describing potential impacts to existing and planned facilities at ORR, followed by descriptions of potential impacts and the environmental impacts of the proposed action on potentially affected environmental resources. The section concludes by describing the potential impacts of tritium supply and recycling on human health during normal operation, the consequences of facility accidents, and regulatory considerations and waste management. Each description addresses the effects of No Action and the potential impacts and environmental impacts of constructing and operating any of the tritium supply technologies collocated with tritium recycling facilities or tritium supply alone at ORR.

#### 4.4.3.1 *Land Resources*

Construction and operation of a tritium supply technology and recycling facilities at ORR would affect land resources, including land use and visual resources. Potential impacts to these resources are summarized below.

ORR has sufficient land area to accommodate any of the proposed tritium supply technologies and recycling facilities. The 600-acre TSS would be located in an undeveloped area of the reservation (figure 4.4.2.1–1). A portion of this area is designated as a National Environmental Research Park. The proposed facilities would create a visual impact to nearby viewpoints with high levels of sensitivity, and result in negative changes in VRM classification of the site. The following sections present the effects of the proposed action on land resources.

**Land Use.**

*No Action.* Under No Action, DOE would continue existing and planned land use activities at ORR as presented in figure 4.4.2.1–1. Any impacts to land use from these actions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Any one of the tritium supply technologies and collocated tritium recycling facilities (section 3.4) the or tritium supply facility alone could be sited at ORR in the proposed TSS (figure 4.4.2.1–1). Land requirements for the tritium facilities are presented in table 4.4.3.1–1. The land area affected ranges from 360 acres for the MHTGR to 173 acres for the APT. An additional 196 acres would be required if the tritium supply facility was collocated with a new recycling facility. As shown in the table, adequate undeveloped land exists. The land use designation would change from forest/undeveloped to industrial. Prime farmland or agricultural activities would not be affected.

No tritium facilities would be constructed offsite, thus offsite land use would not be directly affected. Offsite land is available and could be converted to residential developments to house workers. Such development would be subject to local land use and zoning controls, which vary by jurisdiction.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced capacity to meet a tritium supply requirement less than baseline,

**TABLE 4.4.3.1–1.—*Potential Changes to Land Use Resulting from Tritium Supply Technologies and Recycling at Oak Ridge Reservation***

| | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|
| **Indicator** | **HWR** | **MHTGR** | **ALWR[a]** | **APT[b]** | **Tritium Recycling** |
| Land requirements[c] | 260 | 360 | 350 | 173 | 196 |
| Available land[d,e] (percent) | 1.2 | 1.7 | 1.6 | 0.8 | 0.9 |

[a] Land requirements for both Large and Small ALWR are the same.
[b] Land requirements for both Phased and Full APT are the same.
[c] Land area requirements are estimated to be the same for construction and operation.
[d] Undeveloped land is approximately 21,600 acres.
[e] Any land requirement less than 100 percent means sufficient land.
Source: DOE 1994a; FDI 1993d; FDI 1994a; FDI 1994b; SNL 1993a; OR DOE 1989b.

or the construction and operation of a tritium requirement Phased APT would not change potential baseline land use impacts. Land requirements would be the same in both operation scenarios.

*Potential Mitigation Measures.* Avoidance of steep slopes and special National Environmental Research Park reference and natural areas present in the vicinity of the TSS, through alternative facility layouts, would minimize or eliminate impacts to these areas.

**Visual Resources.**

*No Action.* Under No Action, both existing and planned activities, described in section 4.4.2.1 would continue. Thus, no new facilities would be constructed that could impact visual characteristics at the site. It is also not anticipated that these activities would cause a change in the VRM classification. The existing ORR landscape character would still range from VRM Class 3 to Class 5.

*Tritium Supply and Recycling.* Views of the construction and operation of the proposed tritium supply technologies and recycling facilities would be similar to other existing large industrial facilities at ORR. Of the tritium supply technologies, the APT would be much less visually obtrusive because most of the facility would be low profile (figure 3.4.2.4–1). The existing landscape at the proposed site, presently a VRM Class 4 area, has been moderately disturbed by roads and clear cutting for utility lines. Construction of any of the tritium supply technologies and recycling facilities would impact visual aesthetics. The proposed facilities could result in extensive surface disturbance and would result in a change in the VRM landscape classification of the affected area from Class 4 to Class 5. These facilities would be visible from viewpoints along Bear Creek Road, State Route 58, and/or State Route 95. These viewpoints are highly sensitive because of their relatively high traffic volumes. The use of a wet cooling system for an HWR, MHTGR, or ALWR would potentially result in large cooling towers (up to 50 stories high) and visible plumes during certain atmospheric conditions.

*Less Than Baseline Operations.* Baseline visual impacts would not change due to operation of the HWR, MHTGR or ALWR at reduced capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Mitigation measures such as rerouting public access roadways (State Routes 58 and 95) away from the TSS, or siting the facilities away from these roadways could reduce visual impacts. These measures could provide existing vegetation and/or terrain to screen views and would allow landscaping, including heavy plantings and earth berms to increase screening. Use of alternate architectural designs and special materials for the proposed facilities would help facilities to blend with, or complement, the existing landscape; and/or efficient site planning could minimize surface disturbance to the existing landscape. The use of alternative cooling systems (such as low profile cooling towers or mechanical draft dry cooling systems) could further reduce the visual impacts caused by cooling tower vapor plumes from an HWR, MHTGR, or ALWR.

### 4.4.3.2 *Site Infrastructure*

This section discusses the site infrastructure for No Action and the modifications needed for actions due to construction and operation of new tritium supply and recycling facilities. With nominal increases to fuel procurement contracts, the ORR infrastructure would be capable of supporting any of the proposed tritium supply technologies and recycling facilities selected for the site. A comparison of site infrastructure and facilities resource needs for No Action and the proposed tritium supply alternatives is presented in table 4.4.3.2–1.

**No Action.** The missions discussed in section 3.3.4 would continue under No Action. It is anticipated that certain process improvements to be implemented in the near future would eliminate specific effluents and emissions and reduce or eliminate some waste streams. These process improvements, along with the expected reduction in workload for Y-12, would result in reduced utilities infrastructure requirements for the ORR with the exception of coal use. The increase in coal use is planned to take economic advantage of this fuel source. Estimated reductions for other resource requirements are shown in table 4.4.3.2–1.No modifications are necessary under No Action. The existing site infrastructure would adequately support all No Action missions.

**Tritium Supply and Recycling.** The modifications to the infrastructure at ORR to support the various

TABLE 4.4.3.2–1.—*Modifications to Site Infrastructure for Tritium Supply Technologies and Recycling at Oak Ridge Reservation*

| Alternative | Transportation | | Electrical | | Fuel | | |
|---|---|---|---|---|---|---|---|
| | Roads (miles) | Railroads (miles) | Energy (MWh/yr) | Peak Load (MWe) | Natural Gas (million $ft^3$/yr) | Oil (GPY) | Coal (tons/yr) |
| **Current Resources** | 43 | 17 | 12,368,800 | 1,411 | 3,122 | 980,600 | 25,000 |
| **No Action** | | | | | | | |
| Total site requirement | 43 | 17 | 727,000 | 107 | 3,000 | 900,000 | 35,000 |
| Change from current resources | 0 | 0 | -11,641,800 | -1,304 | -122 | -80,600 | 10,000 |
| **Heavy Water Reactor** | | | | | | | |
| Total site requirement | 43 | 17 | 1,185,000 | 174 | 3,247 | 1,032,000 | 35,000 |
| Change from current resources | 0 | 0 | -11,183,800 | -1,237 | 125 | 51,400 | 10,000 |
| **Modular High-Temperature Gas-Cooled Reactor** | | | | | | | |
| Total site requirement | 43 | 17 | 1,075,000 | 159 | 3,013 | 1,031,000 | 35,000 |
| Change from current resources | 0 | 0 | -11,293,800 | -1,252 | -109 | 50,400 | 10,000 |
| **Large Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 43 | 17 | 1,515,000 | 219 | 3,007 | 1,150,000 | 35,000 |
| Change from current resources | 0 | 0 | -10,853,000 | -1,192 | -115 | 169,400 | 10,000 |
| **Small Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 43 | 17 | 1,195,000 | 175 | 3,007 | 1,060,000 | 35,000 |
| Change from current resources | 0 | 0 | -11,173,800 | -1,236 | -115 | 169,400 | 10,000 |
| **Full Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 43 | 17 | 4,555,000 | 673 | 3,007 | 963,200 | 35,000 |
| Change from current resources | 0 | 0 | -7,813,800 | -738 | -115 | -17,400 | 10,000 |
| **Phased Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 43 | 17 | 3,215,000 | 478 | 3,007 | 963,200 | 35,000 |
| Change from current resources | 0 | 0 | -9,153,800 | -933 | -115 | -17,400 | 10,000 |

A negative number (-) indicates that sufficient resources exist to meet the demands.

Source: FDI 1994h; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; ORR 1993a:8.

tritium supply technologies and recycling facilities are summarized in table 4.4.3.2–1. Table 4.4.3.2–2 summarizes the demands the mission would place on the regional electrical power pool. The pool would be able to meet the additional ORR requirements for any tritium supply technology. The alternatives would require between 1.14 and 12.44 percent of the regional power pool capacity margin. Additional natural gas, oil, and coal fuel requirements could be satisfied through normal contractual means. No other modifications would be necessary.

**Tritium Supply Only.** If new tritium recycling facilities were not collocated with the tritium supply facilities at ORR, and the upgraded recycling facility at SRS were utilized, the overall impact at ORR would be reduced. Onsite transportation network and electrical transmission line requirements would not be affected. The electrical power requirements associated with each of the tritium supply technologies would decrease by 88,000 MWh per year with the peak load decreasing by 16 MWe. This represents a reduction in the total site Peak Power requirement of between 2 and 10 percent with no appreciable change to the capacity margin of the regional power pool. Since the overall electrical requirements still represent a reduction from current requirements, no additional impact would be expected. The natural gas requirement would decrease by 7 million $ft^3$ per year and the fuel oil requirement would decrease by 50,000 gallons per year. This represents a decrease of only about 2 percent in the overall site requirement for natural gas and about 5 percent for fuel oil.

**Less Than Baseline Operations.** In the event that only the steady state component of the baseline tritium requirement is required, the impacts on the site infrastructure would change for some supply technologies. There would be no appreciable change for the HWR, MHTGR, and the ALWR technologies. The Phased APT would reduce electrical consumption by approximately 30 percent but the fuel, onsite transportation infrastructure, and power line requirements would not change.

**Potential Mitigation Measures.** The siting of new tritium supply and recycling facilities would require only minor modifications to the existing site infrastructure. Siting of utility infrastructure could follow existing rights-of-way or be upgraded in place to minimize impacts to natural resources. Where new rights-of-way would need to be constructed, alignments would consider existing sensitive habitat (e.g., wetlands, streams, and vegetation) to minimize the potential for impacting these resources.

### 4.4.3.3 *Air Quality and Acoustics*

Construction and operation of a tritium supply technology and recycling facility at ORR would generate criteria and toxic/hazardous pollutants that could potentially exceed Federal and state ambient air quality standards and guidelines. To determine the air quality impacts, criteria and toxic/hazardous estimated concentrations from each technology have been compared with Federal and state standards and guidelines. Impacts for radiological airborne emissions are discussed in section 4.4.3.9.

In general, all of the proposed technologies would emit the same types of air pollutants during construction. Emissions would typically not exceed Federal, state, or local air quality regulations or guidelines, except that $PM_{10}$ and TSP concentrations may be

**TABLE 4.4.3.2–2.—*Impacts on Regional Electrical Power Pools from Tritium Supply Technologies and Recycling at Oak Ridge Reservation***

| Tritium Supply Technology and Recycling | Peak Power Required (MWe) | Capacity Margin (percent) | Annual Energy Required (MWh) | Total Electricity Production (percent) |
|---|---|---|---|---|
| Heavy Water Reactor | 67 | 1.47 | 458,000 | 0.29 |
| Modular High Temperature Gas-Cooled Reactor | 52 | 1.14 | 348,000 | 0.22 |
| Large Advanced Light Water Reactor | 112 | 2.46 | 788,000 | 0.49 |
| Small Advanced Light Water Reactor | 68 | 1.50 | 468,000 | 0.29 |
| Full Accelerator Production of Tritium | 566 | 12.44 | 3,828,000 | 2.40 |
| Phased Accelerator Production of Tritium | 371 | 8.15 | 2,488,000 | 1.56 |

Source: FDI 1994h; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; ORR 1993a:8.

close to or exceed the 24-hour $PM_{10}$ and TSP standard during peak construction periods. This exceedance is not uncommon for large construction projects.

During operation, impacts from each of the individual tritium supply technologies and recycling facilities with respect to the concentrations of toxic/hazardous air pollutants are predicted to be within standards set forth in Federal, state, and local air quality regulations or guidelines.

The Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on the emission rates presented in appendix table B.1.4–3, Prevention of Significant Deterioration permits may be required for each of the proposed alternatives at ORR. This may require "offsets," reductions of existing emissions, to permit any additional or new emission source.

Noise emissions during either construction or operation are expected to be low. Air quality and acoustic impacts for each technology are described separately. Supporting data for the air quality and acoustics analysis, including modeling results, are presented in appendix B.

**Air Quality**. An analysis was conducted of the potential air quality impacts of emissions from each tritium supply technology and recycling facility. The air quality modeling analysis used the Industrial Source Complex Short-Term model recommended by EPA. The resulting air quality conditions were then evaluated against local and state air quality regulations, and NAAQS (40 CFR 50). The potential exceedance of Prevention of Significant Deterioration (40 CFR 52.21) increments for $PM_{10}$, $SO_2$, or $NO_2$ was also determined.

*No Action*. No Action utilizes estimated air emissions data from current operations at ORR extrapolated to the year 2010 assuming continuation of site missions as described in section 3.3.3. These data reflect conservative estimates of criteria and toxic/hazardous emissions at ORR. The emission rates for the criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.1.4–3. Table 4.4.3.3–1 presents the No Action concentrations. Pollutant concentrations are in compliance with all air quality regulations and guidelines.

*Tritium Supply and Recycling*. Alternatives for ORR consist of four candidate technologies: HWR, MHTGR, ALWR, and APT, alone or collocated with tritium recycling facilities. Air pollutants would be emitted during construction of the tritium supply and recycling facilities. The principal sources of such emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant.
- Exhaust from and road dust raised by construction equipment, vehicles delivering construction material, and vehicles carrying construction workers.

$PM_{10}$ and TSP concentrations are expected to be close to or exceed the 24-hour ambient standard during the peak construction period. Exceedances would be expected to occur during dry and windy conditions. Appropriate control measures would be followed, such as watering to reduce emissions. With the exception of $PM_{10}$ and TSP, it is expected that concentrations of all other pollutants at the ORR boundary or public access highways, would remain within applicable Federal and state ambient air quality standards.

Air pollutant emission sources associated with the operation of each of the technologies include all or part of the following:

- Increased operation of existing boilers to generate additional steam for space heating.
- Operation of diesel generators and periodic testing of emergency diesel generators.
- Recycling operations.
- Exhaust from and road dust raised by vehicles.

TABLE 4.4.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Oak Ridge Reservation* [Page 1 of 2]

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | 2010 No Action ($\mu g/m^3$) | Tritium Supply Technologies and Recycling: HWR ($\mu g/m^3$) | MHTGR ($\mu g/m^3$) | ALWR ($\mu g/m^3$) | APT ($\mu g/m^3$) | Tritium Recycling ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|---|
| **Criteria Pollutant** | | | | | | | | |
| Carbon monoxide (CO) | 8-hour | 10,000 | 5 | 61 | 194 | 75 | 27 | 22 |
| | 1-hour | 40,000 | 11 | 267 | 879 | 334 | 111 | 100 |
| Lead (Pb) | Calendar Quarter | 1.5 | 0.05[a] | 0.05[a] | 0.05[a] | 0.05[a] | 0.05[a] | [c] |
| Nitrogen dioxide ($NO_2$) | Annual | 100 | 3 | 6 | 12 | 11 | 4 | 1 |
| Ozone ($O_3$) | 1-hour | 235 | [b] | [c] | [c] | [c] | [c] | [c] |
| Particulate matter ($PM_{10}$)[d] | Annual | 50 | 9 | 10 | 9 | 9 | 9 | 0.2 |
| | 24-hour | 150 | 56 | 62 | 59 | 61 | 59 | 2.9 |
| Sulfur dioxide ($SO_2$) | Annual | 80 | 29 | 29 | 29 | 29 | 29 | 0.02 |
| | 24-hour | 365 | 105 | 106 | 106 | 106 | 105 | 0.2 |
| | 3-hour | 1,300 | 401 | 405 | 404 | 408 | 402 | 1.2 |
| **Mandated by Tennessee** | | | | | | | | |
| Hydrogen fluoride (as fluorides) | 30-day | 1.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | [e] |
| | 7-day | 1.6 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | [c] |
| | 24-hour | 2.9 | [e] | [e] | [e] | [e] | [e] | [e] |
| | 12-hour | 3.7 | [e] | [e] | [e] | [e] | [e] | [e] |
| | 8-hour | 250 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | [c] |
| Total suspended particulates[d] | Annual | 60 | 33 | 34 | 33 | 33 | 33 | 0.2 |
| | 24-hour | 150 | 75 | 81 | 78 | 80 | 78 | 2.9 |
| **Hazardous and Other Toxic Compounds** | | | | | | | | |
| Acetone | 8-hour | 178,000 | [c] | [c] | [c] | 9.7 | [c] | [c] |
| Acetylene | 8-hour | [f] | [c] | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 |
| Ammonia | 8-hour | 1,700 | [c] | [c] | [c] | 5.1 | [c] | [c] |
| Chlorine | 8-hour | 150 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | [e] |
| Chlorodifluoromethane | 8-hour | 354,000 | 18.6 | 18.6 | 18.6 | 18.6 | 18.6 | [c] |
| Dichlorodifluoromethane | 8-hour | 495,000 | 16.3 | 16.3 | 16.3 | 16.3 | 16.3 | [c] |
| Ethyl alcohol | 8-hour | 188,000 | [c] | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |

**TABLE 4.4.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Oak Ridge Reservation* [Page 2 of 2]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling (μg/m³) |
| **Hazardous and Other Toxic Compounds** (Continued) | | | | | | | | |
| Hydrogen chloride | 8-hour | 750 | 37.3 | 37.3 | 37.3 | 37.3 | 37.3 | [c] |
| Methane | 8-hour | [f] | [c] | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 |
| Methyl alcohol | 8-hour | 26,200 | 140.7 | 141.9 | 141.9 | 141.9 | 141.9 | 1.2 |
| Nitric acid | 8-hour | 520 | 50.8 | 56.6 | 50.8 | 118.5 | 50.8 | [c] |
| Sulfuric acid | 8-hour | 100 | 13.1 | 13.1 | 13.1 | 13.1 | 13.1 | [c] |
| Tetrachloroethylene | 8-hour | 33,900 | 65.3 | 65.3 | 65.3 | 65.3 | 65.3 | [c] |
| 1,1,1-Trichloroethane | 8-hour | 191,000 | 4 | 4.9 | 4.3 | 26.2 | 4 | [c] |
| Trichlorofluoromethane | 8-hour | 562,000 | 42.6 | 42.6 | 42.6 | 42.6 | 42.6 | [c] |
| Trichlorotrifluoroethane | 8-hour | 767,000 | 14.6 | 55.7 | 14.6 | 14.6 | 14.6 | [c] |

[a] Value is maximum for a 24-hour period.
[b] No monitoring data available.
[c] No sources indicated.
[d] It is conservatively assumed that all $PM_{10}$ concentrations are TSP concentrations.
[e] Data unavailable.
[f] There is no standard.

Note: Concentrations for tritium supply and recycling include 2010 No Action concentrations. To determine the concentrations of pollutants from each tritium supply technology, subtract the pollutant concentration for tritium recycling from each of the tritium supply and recycling concentrations.

Note: DOE is committed to the phaseout of ozone-depleting substances and will discontinue use of these substances according to EPA phaseout schedules.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; OR DHE 1991a; ORR 1993a:8.

Appendix table B.1.4–3 presents emissions from each of the proposed tritium supply technology and recycling facilities. There are no gaseous releases associated with the APT (SNL 1995a), although emissions are associated with operation of the tritium supply facility included with the APT and with recycling facilities. Emissions from the Large ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Concentrations of pollutants from the operation of each of the tritium supply and recycling facilities at ORR are presented in table 4.4.3.3–1. Pollutant concentrations, combined with No Action concentrations, are in compliance with Federal and state standards.

Pollutant emissions resulting from the operation of tritium supply technologies alone (HWR, MHTGR, ALWR and APT) consist of criteria pollutants from the operation of boilers and diesel generators and toxic/hazardous pollutant emissions from facility processes. Criteria pollutant emissions from the MHTGR are the highest among the other tritium supply technologies and would increase existing total site criteria pollutant emissions by less than 5 percent above No Action emissions. Concentrations of criteria and toxic/hazardous pollutants, added to No Action concentrations, are in compliance with Federal and state standards.

*Less Than Baseline Operations.* Air emissions from the HWR would be reduced slightly when operated at reduced capacity. However, the reduction would be negligible since most emissions are attributed to support equipment and facilities that are not related to the reactor operating level. The MHTGR or ALWR would have no change in air emissions because it would continue to operate at the same level as the baseline requirement to maintain power levels for steam or electrical production. The Phased APT construction and operation emissions and impacts would be the same as the Full APT.

*Potential Mitigation Measures.* Potential mitigation measures during construction include watering to reduce dust emissions; applying nontoxic soil stabilizers to all inactive construction areas; cover, water, or apply nontoxic soil binders to exposed piles (i.e., gravel, sand, dirt); suspend all excavation and grading operations when wind speeds warrant; pave construction roads that have a traffic volume of more than 50 daily trips by construction equipment; use electricity from power poles rather than temporary gasoline and diesel power generators. Potential mitigation measures during operation include incorporating additional HEPA filters to reduce particulate emissions from processing facilities; substituting cleaning solvents for those that present health hazards or exceed the applicable standards; and switching from coal or fuel oil to produce electricity or steam to natural gas to reduce criteria pollutants.

**Acoustics.** The location of the tritium supply technologies and recycling facilities relative to the site boundary and sensitive receptors was examined to determine the contribution to noise levels at these locations and the potential for onsite and offsite impacts.

*No Action.* The continuation of operations at ORR would result in no appreciable change in traffic noise and onsite operational noise sources from current levels (section 4.4.2.3). The nontraffic noise sources associated with operation are located at sufficient distance from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

*Tritium Supply and Recycling.* Noise sources during construction may include heavy-construction equipment and increased traffic. Increased traffic would occur onsite and along major offsite transportation routes used to bring construction material and workers to the site.

Most nontraffic noise sources associated with operation of any of the tritium supply and recycling facilities would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would continue to be small. Based on the size of the site, noise emissions from construction equipment and machinery and from operational facilities, equipment, explosives, and machinery would not be expected to cause annoyance to the public.

Noise impacts associated with increased traffic on access routes would be considered in tiered NEPA documents. Some nontraffic noise sources associated with construction and operation of the tritium supply technologies and recycling facilities may be located close enough to offsite noise receptors that they could experience some increase in noise levels.

*Less Than Baseline Operations.* Baseline noise impacts would not change due to reactors operating at reduced capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Potential measures to minimize noise impacts on workers include the use of standard silencing packages on construction equipment and providing workers in noisy environments with appropriate hearing protection devices meeting OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

#### 4.4.3.4 *Water Resources*

Environmental impacts associated with the construction and operation of the proposed tritium supply technologies and recycling facilities at ORR would affect both surface water and groundwater resources. The proposed site for the tritium supply and recycling facilities would be outside any 100-year floodplain. Complete information on the location of the 500-year floodplain at ORR is currently unavailable. At ORR, surface water resources, primarily the Clinch River, would be used to meet all construction and operation water requirements. The Clinch River has sufficient flow to support any of the tritium supply technologies and recycling facilities. During construction, treated sanitary wastewater would be discharged in compliance with NPDES permit requirements to nearby streams. No construction-related discharge would exceed 0.2 percent of the Clinch River's average flow. Any construction-related impacts would be mitigated by standard erosion control practices with the exception of the large amount of dewatering wastewater generated during the construction of the MHTGR and APT where detention basins may become necessary to control the discharge.

During operation of the tritium supply and recycling facilities, treated wastewater and cooling system blowdown would be discharged to nearby streams. Because of the manner in which blowdown is usually released (e.g., high velocity pulsed releases), it has the potential to scour streambeds and erode stream banks of small receiving streams. Impacts from blowdown velocity and elevated temperatures can be mitigated with energy dissipating structures, cooling water canals, or retention basins. During operation, stormwater runoff would be collected, and treated if necessary, before discharge to natural drainage channels in accordance with NPDES permit requirements.

Minimal impacts to groundwater are anticipated because no water will be withdrawn and no direct discharges would occur during construction and operation. Table 4.4.3.4–1 presents existing surface water and groundwater resources and the potential changes to water resources at ORR resulting from the proposed tritium supply technologies and recycling facilities. Resource requirements for each tritium supply technology shown in this table represent the total requirements at the site, including No Action. Resource requirements for tritium recycling are added to these values to obtain water resource requirements for assessing impacts associated with combined tritium supply and recycling.

**Surface Water.**

*No Action.* Under No Action, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities which are independent of and not affected by the proposed action. A description of the activities that would continue at ORR is provided in section 3.3.4. Under No Action, because of reduced operating requirements of existing facilities at ORR, surface water withdrawals from the Clinch River are expected to decrease to 0.2 percent of the river's average flow. Wastewater discharges from Y-12 would continue to East Fork Poplar Creek and Bear Creek although the volume would decrease.

*Tritium Supply and Recycling.* Surface water withdrawals during construction of any tritium supply technology, with or without the tritium recycling facilities, would comprise no more than 0.2 percent of the Clinch River's average flow and would therefore have no adverse effect on flow or downstream users. Treated wastewater effluent released to surface streams would be less than 0.002 percent of the average flow of the Clinch River. Similarly, discharges to East Fork Poplar Creek would not exceed 0.2 percent of the creek's average flow. All discharges would be monitored to comply with NPDES permit and other discharge requirements. The potential impacts during construction would be erosion of disturbed land and siltation in surface waters. To minimize soil erosion impacts,

TABLE 4.4.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Oak Ridge Reservation* [Page 1 of 2]

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | Tritium Recycling[b] |
| | | | | Large | Small | Full | Phased | |
| **Construction** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Surface | Surface | Surface | Surface | Surface | Surface | Surface | Surface |
| Total water requirement (MGY)[c] | 1,849 | 1,870 | 1,867 | 1,882 | 1,869 | 1,857 | 1,857 | 1.5 |
| Percent increase in projected water use | 0 | 1 | 1 | 2 | 1 | 1 | 1 | NA |
| Percent of Clinch River flow | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to surface waters (MGY) | NA | 16.5 | 13.6 | 27.5 | 15.5 | 0.3 | 0.3 | 0.9 |
| Percent change in stream flow[d] | NA | 0.001 | 0.001 | 0.002 | 0.001 | <0.001 | <0.001 | NA |
| NPDES permit required | NA | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| **Operation** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Surface | Surface | Surface | Surface | Surface | Surface | Surface | Surface |
| Total water requirement[e] | 1,849 | 7,749 | 5,879 | 17,849 | 9,049 | 4,491 | 3,540 | 14 |
| Percent increase in projected water use | 0 | 319 | 218 | 865 | 389 | 143 | 91 | NA |
| Percent of Clinch River flow | 0.2 | 0.7 | 0.5 | 1.6 | 0.8 | 0.4 | 0.3 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to surface waters (MGY) | f | 48 | 30 | 90 | 50 | 7 | 65 | 13 |
| Percent change in stream flow[d] | NA | <0.01 | <0.01 | <0.01 | <0.01 | <0.001 | <0.001 | NA |
| Blowdown discharge to surface waters[g] (MGD) | NA | 9.6 | 6.7 | 25.8 | 11.7 | 2.2 | 1.2 | 9 |
| Percent change in stream flow[g] | NA | 7.3 | 5.1 | 19.6 | 8.9 | 1.7 | 0.9 | NA |
| NPDES permit required | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA |

**TABLE 4.4.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Oak Ridge Reservation* [Page 2 of 2]**

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | Tritium Recycling[b] |
| | | | | Large | Small | Full | Phased | |
| **Floodplain** | | | | | | | | |
| Actions in 100-year floodplain | NA | No | No | No | No | No | No | No |
| Critical actions in 500-year floodplain | NA | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain |
| Floodplain assessment required | NA | Yes<br>500-year | Yes<br>500-year | Yes<br>500-year | Yes<br>500-year | Yes<br>500-year | Yes<br>500-year | NA<br>NA |

[a] Operational water requirements for MHTGR and ALWR include utilization of turbine generators.

[b] Resource requirements for tritium recycling do not include No Action. The values presented in this column are added to the requirements of each tritium supply technology to assess the impacts associated with combined tritium supply and recycling.

[c] Total water requirements for construction at ORR are calculated by adding baseline requirements (1,849 MGY) with that for each tritium supply technology (with recycling): HWR (21.3 MGY), APT (8.3 MGY), MHTGR (17.8 MGY), and ALWR (33.3 MGY for Large and 20 MGY for Small).

[d] Percent change in stream flow from wastewater discharge is calculated from the average flow of Clinch River (4,882 $ft^3$/sec) and East Fork Poplar Creek (51.4 $ft^3$/sec). The comparison for Clinch River is shown in the table.

[e] Total water requirements for operation at ORR are calculated by adding baseline requirements (1,849 MGY) with that for each tritium supply technology (with recycling): HWR (5,900 MGY), APT (1,691 MGY for Phased and 2,642 MGY for Full), MHTGR (4,030 MGY), and ALWR (16,000 MGY for Large and 7,200 MGY for Small).

[f] Existing discharges directly into the Clinch River are negligible compared to the base flow of the river. Existing discharges to East Fork Poplar Creek are downstream of Y-12 and the city of Oak Ridge wastewater plant discharges.

[g] Blowdown is expected to occur once a day over a 1-hour period, rather than continuously over the course of the day. As such, the discharge rate would be much greater for a shorter period of time. Blowdown discharges are assumed to be directed to the same streams as wastewater discharges.

Note: NA - not applicable.

Note: Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; ORR 1993a:8.

stormwater management and erosion control measures would be implemented.

In addition to wastewater effluent, MHTGR or APT would require dewatering because of construction activities below the water table. The amount of dewatering discharges would depend on hydrologic and engineering conditions of the site. These discharges could either be directed to Clinch River or East Fork Poplar Creek and are expected to exhibit low turbidity and not require settling basins. However, temporary sediment basins to remove soil particles could be built as part of standard soil erosion and sediment control plans for the site. Dewatering discharges to East Fork Poplar Creek could cause stream bank erosion, increased turbidity, stream bed scouring, and potential flooding. More detailed analyses would be conducted during site-specific NEPA studies to evaluate the site conditions and the amount of dewatering needed, construction techniques to reduce dewatering, and to identify mitigation measures. Construction of an HWR or ALWR would require much less dewatering, and the impact on East Fork Popular Creek or Clinch River are expected to be minor.

Operation of the Large ALWR would require the most water, approximately 18,000 MGY or approximately 1.6 percent of the Clinch River's average flow. The other tritium supply technologies, with or without tritium recycling, would require no more than 0.8 percent of this flow. Treated sanitary, process, and utility wastewater discharge of the Large ALWR with recycling (109 MGY) released to East Fork Poplar Creek would not exceed 1 percent of the creek's average flow and therefore should not result in any downstream effects. Release to the Clinch River would represent less than 0.01 percent of the average flow. All discharges would be monitored to comply with NPDES permit limits. Stormwater runoff from the main plant area would be collected in detention ponds, monitored, and if acceptable, discharged to nearby streams. Stormwater runoff from outside the main plant area, except those facilities that require onsite management controls by regulation such as sanitary wastewater treatment plants and landfills, would be discharged to nearby streams.

Unlike wastewater effluent from treatment facilities, which is released on a continuous basis, cooling system blowdown activities discharge greater quantities over a shorter period of time. The Large ALWR would release approximately 26 million gallons of blowdown water once a day over a 1-hour period. The other tritium supply technologies would release less than half of this amount. Without engineered measures such as those described under "Potential Mitigation Measures," blowdown from the Large ALWR and other tritium supply technologies would temporarily increase the average flow rate of receiving streams by 20 percent (for Clinch River) and 1,880 percent (for East Fork Poplar Creek). These discharges would cause scouring of streambeds, erosion of stream channels, increased turbidity, and potential flooding of areas. In addition to impacts from the discharge velocity of the blowdown, the high temperature of the releases could also affect receiving waters. Engineering measures incorporated in technology design adapted to site conditions could significantly reduce these impacts. Various cooling system blowdown disposal options would be evaluated in site-specific tiered NEPA documents. All discharges to surface waters would be subject to and required to comply with NPDES permit requirements.

Blowdown would also contain concentrated chemicals and diffused tritium. Depending on the operation of the system, blowdown chemical and tritium concentrations would range from between 2.5 and 5 times the river water concentrations. Previous studies of tritium concentrations in liquid discharges from reactors operating at higher production rates than anticipated for the proposed facilities showed that the concentration in the receiving water of a river having a comparable flow to the Clinch River did not exceed the water quality standard of 20,000 pCi/l after dilution. For the purpose of this analysis, it is anticipated that any release of tritium from the proposed facilities would not exceed the water quality standard for tritium and would comply with NPDES discharge requirements. For information on the radiological constituents present in cooling system blowdown, refer to section 4.4.3.9.

The proposed site for the tritium supply and recycling facilities lies outside the 100-year floodplain. However, since 500-year floodplain information does not exist for this portion of ORR, and because operation of the tritium supply and recycling facilities may constitute a critical action, an assessment of

the 500-year floodplain would be required before construction activities were initiated. This study would be done for site-specific assessments and appropriate design considerations made on the results.

*Less Than Baseline Operations.* Operation of the HWR at reduced capacity to meet a tritium supply requirement less than baseline would reduce slightly the operation water requirements and the quantity of water discharges. A reduction in the temperature of cooling water discharges would be expected because of the lower thermal output of the reactor. The MHTGR or ALWR water requirements and discharges would not change from the baseline, therefore the potential impacts would remain the same.

Operation of the Phased APT would require 3,540 MGY (see Table 4.4.3.4–1), a 91 percent increase over projected No Action water use. This is approximately two thirds of the 143 percent increase required by the Full APT, and is 0.3 percent of the Clinch River's average flow. The 65 MGY of wastewater discharges from the Phased APT would not exceed 1 percent of Clinch River's average flow and should not have any downstream effects. The Phased APT will discharge 1.2 million gallons of blowdown water during one hour every day. This is approximately one half the blowdown discharge of the Full APT, and is 0.9 percent of Clinch River's average flow and 87 percent of East Fork Poplar Creek's average flow. This discharge is less than the blowdown of the other technologies and its impacts would be less than but similar to those of other technologies. All other requirements of the Phased APT are identical to those of the Full APT.

*Potential Mitigation Measures.* Surface water impacts associated with construction could be mitigated by applying standard erosion control practices. Impacts from operational discharges, such as scouring and erosion in stream channels, could be mitigated through retention basins to accommodate the volume of wastewater flow. Blowdown velocity and temperature impacts could be mitigated with energy dissipating structures such as plunge or stilling basins, cooling water canals, or retention basins. Lined conveyance channels with additional energy dissipation features could also be designed to further reduce the velocity of flow prior to entering the natural stream channel and discharges directed through a series of detention ponds to reduce discharge velocities and allow the water to cool.

**Groundwater.**

*No Action.* Under No Action, no additional impacts to groundwater resources are anticipated beyond the effects of existing and future activities which are independent of and unaffected by the proposed action. A description of the activities that would continue at ORR is provided in section 3.3.4. Currently, no groundwater is used.

Water quality data obtained from wells located near the Y-12 facility indicate that water quality is above or bordering drinking water standards for a number of parameters (table 4.4.2.4–1). Under No Action, current restoration programs would continue. Process and wastewater would continue to be treated at either the Y-12 Central Pollution Control Facility or at the Y-12 West End Treatment Facility before being released to surface waters. Minimal impacts on groundwater quality are expected due to wastewater releases.

*Tritium Supply and Recycling.* All water for construction and operation of tritium supply technologies and recycling facilities would be taken from the Clinch River, with no plans for withdrawal from groundwater resources. All process, utility, and sanitary wastewater will be treated prior to discharge into East Fork Poplar Creek in accordance with NPDES permits. Minimal impact to groundwater quality is expected.

*Less Than Baseline Operations.* Potential groundwater quality impacts described above would not change due to changes in reactor operating capacities, or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* No mitigation measures have been identified because no impacts to groundwater resources are anticipated.

### 4.4.3.5 *Geology and Soils*

Construction of tritium supply and recycling facilities at ORR would have no impact on geological resources, and hazards posed by geological

conditions are expected to be minor. Construction could disturb a few hundred surface acres of soil, the amount depending on the tritium supply technology and the collocation of recycling facilities. Control measures would be used to minimize soil erosion. Impacts would depend on the specific soil units in the disturbed area, the extent of land disturbing activity, and the amount of soil disturbed. Potential changes to geology and soils associated with the construction and operation of tritium supply and recycling facilities at ORR are discussed below.

*No Action.* Under No Action, DOE would continue existing and planned activities at ORR. Any impacts to geology and soils from these actions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Construction activities would not affect geologic conditions. Facility design would ensure that they would not be adversely affected by geologic conditions.

There are no known capable faults within the boundaries of ORR. There is little chance for ground rupture as a result of an earthquake; minor ground shaking is more likely but is not anticipated during the life of the proposed project. Intensities of more than VI on the modified Mercalli scale are not likely at ORR. Ground shaking could affect the integrity of poorly designed or nonreinforced existing structures but would not affect newly designed facilities. Based on the seismic history of the area, low seismic risk exists at ORR and should not preclude safe construction and operation of a tritium supply and collocated recycling facilities or tritium supply facility alone. In addition, facilities would be designed for earthquake-generated ground acceleration in accordance with DOE Order 5480.28 and accompanying safety guides.

Volcanic activity has not occurred in the area for over 200 million years and is extremely unlikely to impact the project. It is also highly unlikely that landslides or other nontectonic movements would affect project activities. Slopes and underlying foundation materials are generally stable. Sinkholes are present in the Knox Dolomite, but it is unlikely that they would impact the project, as the Knox Dolomite is not present in Bear Creek Valley (potential site). Potential health impacts from accidents associated with geological hazards are discussed in section 4.4.3.9.

Properties and conditions of soils underlying the proposed site have no limitations on construction. Soils would be impacted by construction and operation of the facilities. The amount of acreage that would potentially be disturbed by the tritium supply technologies and tritium recycling facilities is shown in table 4.4.3.1–1. Soils, therefore, would not adversely effect the safe operation of project activities.

The soil disturbance from construction of new facilities could be as much as 562 acres for a collocated MHTGR with the new recycling facilities. Disturbance would occur at building, parking, and construction laydown areas, destroying the soil profile, and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and, particularly during the construction period, the duration of time the soil is bare. Construction of both the MHTGR and the APT would also necessitate deep excavations to accommodate reactor modules and an accelerator tunnel, respectively (sections 3.4.2.2 and 3.4.2.4). A considerable volume of spoil would be removed as a result of the excavations. Most of the material removed would be shale and limestone bedrock and could be stockpiled for use as fill. Some of this material could be used to cover the accelerator tunnel of the APT. Site-specific NEPA studies would evaluate in detail impacts to geology and soils at ORR resulting from deep excavations required for the MHTGR and the APT and would identify appropriate mitigation measures.

Net soil disturbance during operation would be less than for construction because some areas temporarily used for laydown would be restored. Although erosion from stormwater runoff and wind action could occur occasionally during operation, it is anticipated to be minimal.

Appropriate erosion and sediment control measures would be used to minimize soil loss. Wind erosion is likely to occur on an intermittent basis, depending on

the wind velocities, the amount of soil exposed, and the effectiveness of control measures.

*Less Than Baseline Operations.* Under less than baseline tritium requirement operation, geology and soil impacts would not change for the HWR, MHTGR or ALWR technologies. Disturbed acreage for the Phased APT would be the same as the baseline tritium requirement case Full APT, therefore impacts would be the same.

*Potential Mitigation Measures.* Mitigation measures would be required to control erosion of soil, especially during construction. Potential measures include accepted standard practices for erosion, sediment, and dust control such as silt fences, sediment traps, runoff diversion dikes, drainageways, sedimentation ponds, establishment of ground cover and windbreaks, grading of slopes, and construction of berms or other controls appropriate to the sites. Standard control for wind erosion, such as wetting the surface, could be done on a need-to basis. Exposing only small areas for limited periods of time, as necessary, could also reduce erosional effects. After the construction period, long-term control measures could include grading, revegetation or landscaping.

### 4.4.3.6 *Biotic Resources*

Construction and operation of tritium supply and recycling facilities at ORR would affect biotic resources. Impacts resulting from the construction of the HWR, MHTGR, ALWR, or Full APT to meet the baseline tritium requirement would occur only at the beginning of the project life cycle. The less than baseline tritium requirement Phased APT could incur some additional construction-related impacts if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion would occur in the already developed main plant site. Impacts to terrestrial resources would result from the loss of habitat during construction and operation. Displacement of wetlands would be avoided or mitigated in cooperation with the U.S. Army Corps of Engineers and state agencies. Without mitigation measures, water discharged during construction and operation could disturb wetlands and aquatic habitat. No Federal-listed threatened or endangered species would be affected by the proposed action. However, several special status plant species could be destroyed and special status animal species could be affected, primarily through the loss of potential foraging, nesting, or spawning habitat during construction. Where potential conflicts could occur, mitigation measures would be developed in consultation with the USFWS. Consultation would be conducted at the site-specific level in tiered NEPA documents. Table 4.4.3.6–1 summarizes the potential changes to biotic resources at ORR resulting from the proposed action. No major differences in impacts to biotic resources exist between the four tritium supply technologies and recycling facilities. However, MHTGR or APT-related construction and operation discharges have the potential to impact wetlands and aquatic resources to a greater degree than the other tritium supply technologies.

**Terrestrial Resources.**

*No Action.* Under No Action, the missions described in section 3.3.3 would continue at ORR. This would result in no changes to current terrestrial conditions at ORR described in section 4.4.2.6.

*Tritium Supply and Recycling.* Construction and operation of the HWR, MHTGR, ALWR, or APT in the proposed TSS would result in the disturbance of approximately 462, 562, 552, or 375 acres, respectively, or 1.6 percent or less of ORR (table 4.4.3.6–1). These acreages include areas on which the tritium supply and recycling facility would be constructed, as well as areas that would be revegetated following construction.

Vegetation within the area to be developed would be destroyed during land clearing. Vegetation cover within the proposed TSS is predominantly oak-hickory forest or pine and pine-hardwood forest (figure 4.4.2.6–1). While both types would be affected by construction, it is likely that a greater area of pine and pine-hardwood forests would be removed. This type of forest is more heavily concentrated in valleys where most of the development would occur. Oak-hickory forests are typically found on ridges. Both forest types are common throughout ORR and within the region.

Constructing any of the tritium supply technologies and recycling facilities would have some adverse effects on animal populations. Less mobile animals

**TABLE 4.4.3.6–1.—*Potential Impacts to Biotic Resources During Construction and Operation Resulting from Tritium Supply Technologies and Recycling at Oak Ridge Reservation***

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | Tritium Recycling |
| Acres of habitat disturbed | 0 | 462[a] | 562[a] | 552[a] | 375[a] | 202 |
| Wetlands potentially impacted | None | Yes | Yes | Yes | Yes | Yes |
| Aquatic resources potentially impacted | None | Yes | Yes | Yes | Yes | Yes |
| Number of threatened and endangered species potentially affected[b] | 0/0 | 0/12 | 0/12 | 0/12 | 0/12 | 0/12 |

[a] Acreage distributed by each tritium supply technology only may be obtained by subtracting the acreage for the tritium recycling facility from the tritium supply technologies and recycling acreage.

[b] The number of threatened and endangered species are represented by two data inputs (a/b) where: a = the number of Federal-listed threatened and endangered species and b = the number of all other special status species (i.e., Federal candidate and/or state-listed species) that are potentially impacted.

Source: DOE 1992k; DOE 1992o:1; FDI 1993a; FDI 1993c.

within the proposed project area, such as amphibians, reptiles, and small mammals, would be destroyed during land-clearing activities. Construction activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. The long-term survival of these animals would depend on whether the area where they migrated to was at or below its carrying capacity. Nests and young animals living within the proposed TSS could be lost during construction. Upon completion of construction, revegetated areas would be of minimal value to most wildlife since they would be maintained as landscaped areas.

Salt drift from wet cooling towers may cause salt deposition on surrounding land areas and vegetation. Recent data on deposition rates from a similar sized cooling tower at ORR are not available. However, previous studies for a proposed tritium reactor at SRS, which was designed for the southeastern United States, would be expected to be applicable to ORR. The proposed SRS reactor was predicted to impact 13 acres at a deposition rate of 15.2 pounds per acre per month. This is the level at which salt stress symptoms could become evident on sensitive plants (DOE 1992e). While specific data are not available, all the proposed tritium supply technologies and recycling facilities would use less water than the previous SRS design. Assuming similar parameters for the ORR and SRS cooling towers, impacts from salt drift at ORR are expected to be less. Potential impacts would be further reduced since a portion of the salt drift would fall on developed areas in the vicinity of the cooling tower.

Activities associated with facility operation, such as noise and human presence, could affect wildlife living immediately adjacent to the tritium supply and recycling facility. These disturbances may cause some species to move from the area.

Construction and operation of a tritium supply facility alone would result in similar impacts to terrestrial resources but less than those described for a collocated tritium supply and recycling facility. Impacts would be less since 202 fewer acres of habitat would be disturbed.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have the same impacts described above for production at baseline tritium requirements.

Construction-related impacts of the less than baseline tritium requirement Phased APT would be similar to those described above. Some additional construction-related impacts could occur if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion activities would occur in the already developed main plant site.

*Potential Mitigation Measures.* The loss of habitat due to construction and operation of tritium supply and recycling facilities may be mitigated by revegetating with native species where possible. Disturbance to wildlife living in areas adjacent to the facility may be minimized by preventing workers from entering undisturbed areas. It may be necessary to survey the TSS for the nests of migrating birds prior to construction and/or avoid clearing operations during the breeding season.

**Wetlands.**

*No Action.* Under No Action, the missions described in section 3.3.3 would continue at ORR. This would result in no change to site wetlands. Section 4.4.2.6 describes current wetland resource conditions at ORR.

*Tritium Supply and Recycling.* Because the majority of the area in which the proposed tritium supply technology and recycling facilities would be located is upland, it is expected that direct impacts to wetlands could be avoided. Implementation of erosion and sediment control measures would control secondary impacts. Any unavoidable displacement of wetlands would be made in accordance with the requirements of the U.S. Army Corps of Engineers permit and the Tennessee *Water Quality Control Act.*

Construction-related discharges would be directed to either East Fork Poplar Creek or the Clinch River. Discharges to the Clinch River would have a minimal impact on the flow of the river and are not expected to affect associated wetlands. Discharges associated with dewatering from the MHTGR or APT to East Fork Poplar Creek could result in increased flow (section 4.4.3.4). This could cause a temporary rise in the local water table adjacent to the stream, especially during periods of low flow in the summer and fall. An increase in water levels in wetlands adjacent to the creek could favor plants better adapted to growing in wet soil conditions. Consequently, the composition of the wetland communities adjacent to the stream could change to plants favoring wet soil conditions. Additionally, the extent of any existing wetlands could also increase.

Scouring of the streambed of East Fork Poplar Creek due to high flow rates could result in the deposition of sediments downstream. If this deposition occurred in wetland areas, it could also change wetland vegetation composition. Construction of detention ponds to control the release of water would reduce impacts to wetlands associated with the creek. All wastewater discharges would be required to meet NPDES permit and Tennessee *Water Quality Control Act* requirements.

During operation of the tritium supply technologies and recycling facilities, blowdown water from the cooling system would also be discharged to either East Fork Poplar Creek or the Clinch River (section 4.4.3.4). If directed to East Fork Poplar Creak, large intermittent discharges of blowdown could result in streambed scouring and subsequent deposition of sediments in downstream areas. If deposition occurs in wetland areas, the vegetation composition of these wetlands could change. Thermal impacts to wetland vegetation could occur with the release of large volumes of cooling system water.

Due to the larger volume of water in the Clinch River, impacts to wetlands bordering the river would not be as great as those to wetlands along East Fork Poplar Creek. However, flows would be large enough (section 4.4.3.4) to cause streambed scouring in the vicinity of the outfall. Therefore, if present, wetlands in the vicinity of the outfall could be altered. All wastewater discharges would be required to meet NPDES permit and Tennessee *Water Quality Control Act* requirements.

Impacts on wetlands are not expected from salt deposition from the tritium supply technologies and recycling facilities. Any impacts that would occur would be limited to a relatively small area. All the tritium supply technologies and recycling facilities could be sited at a sufficient distance from wetlands to avoid any potential impacts from salt deposition.

Construction and operation of a tritium supply facility alone would result in similar impacts to wetlands but slightly less than those described for a collocated tritium supply and recycling facility. This is the case since both land and water requirements would be less.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have the same types of wetland impacts described above for the baseline tritium

production requirement. However, operation of the HWR at reduced capacity would potentially reduce the volume of cooling water discharges and may result in less wetland vegetation impacts. The MHTGR or ALWR related wetland impacts would not change from the baseline tritium production requirement consequences since the reactor would operate at the same level to maintain power levels for steam or electrical production. Construction and operation of a Phased APT would have similar wetlands impacts as described for the Full APT.

*Potential Mitigation Measures.* Construction impacts to wetlands could be avoided by siting the tritium supply and recycling facilities in areas away from wetland habitat. Construction impacts could also be reduced by implementing soil erosion and sediment control measures. The use of detention ponds could reduce cooling system water discharges to wetlands adjacent to East Fork Poplar Creek. Unavoidable impacts to wetlands would be mitigated according to DOE policy as set forth in 10 CFR 1022 and in accordance with the U.S. Army Corps of Engineers requirements. All effluent discharges to wetlands would be required to meet NPDES permit and Tennessee *Water Quality Control Act* requirements.

**Aquatic Resources.**

*No Action.* Under No Action, the missions described in section 3.3.3 would continue at ORR with no additional impacts to water bodies on the ORR. Currently, the only notable impacts are entrainment and impingement losses of fish species resulting from water withdrawal, and possible reduction in species diversity in some water bodies on the ORR due to reduced water quality. Section 4.4.2.6 describes the current aquatic resource conditions at ORR.

*Tritium Supply and Recycling.* Construction of the HWR, MHTGR, ALWR, or APT could cause water quality changes (primarily sediment loading and resulting turbidity) to Bear Creek, Grassy Creek, or Ish Creek as a result of soil erosion. These changes would vary according to the acres disturbed by each tritium supply technology (table 4.4.3.6–1). Soil erosion and sediment control measures would be implemented to control erosion. Construction water withdrawal would represent a very small percentage of the Clinch River's average flow and would have little affect on the flow of the river. Impingement and entrainment impacts would, therefore, be minimal and would be unlikely to affect fish populations in the Clinch River. During construction, dewatering discharges would be directed to either East Fork Poplar Creek or the Clinch River. Dewatering discharges from the HWR and ALWR would result in minor impacts to either stream or river (section 4.4.3.4). However, during construction of the MHTGR or APT, dewatering discharges, without design mitigation, could cause streambed scouring and increased turbidity in East Fork Poplar Creek. This could eliminate some fish spawning and feeding habitat. Aquatic life would be displaced during construction but would likely recolonize after construction is complete and water quality returns to normal. If dewatering discharges from the HWR or APT were directed to the Clinch River they would represent a small percentage of the river flow.

During operation, water withdrawals could increase entrainment and impingement of fish in the Clinch River. However, the greatest amount of water required would comprise a small percentage of the Clinch River's average flow and is unlikely to affect fish populations. Treated wastewater would be discharged to either East Fork Poplar Creek or the Clinch River; however, it would only represent a small percentage of the flow of either stream (section 4.4.3.4) and would minimally affect aquatic resources.

Blowdown water from the cooling system of a tritium supply and recycling facility would be released to either East Fork Poplar Creek or the Clinch River during operation. Without mitigation, intermittent discharge of large volumes of blowdown water would greatly increase the flow rate of East Fork Poplar Creek (section 4.4.3.4). This could result in flooding and/or streambed scouring and, as a result, alter aquatic resources by displacing existing plant and animal communities. Discharge of cooling system blowdown water to the Clinch River would represent up to 20 percent of the flow of the river during each discharge period (section 4.4.3.4). This could result in streambed scouring in the vicinity of the outfall and subsequent downstream sedimentation. Although fish would likely return to the disturbed area between periods of discharge, this would not be possible for benthic organisms. Thermal impacts may also occur as the result of the

release of large intermittent volumes of cooling water. Mitigation measures would be required to lessen impacts to either East Fork Poplar Creek or the Clinch River. Chemical constituents and temperature of the discharges would be required to meet NPDES permit and Tennessee *Water Quality Control Act* requirements. If temperature limits were not met, a Section 316a demonstration of a balanced biotic community would be required.

Construction and operation of a tritium supply facility alone would result in similar impacts to aquatic resources but slightly less than those described for a tritium collocated supply and recycling facility. This is the case since both land and water requirements would be less.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have the same type of impacts to aquatic resources at ORR as described above for the baseline tritium production requirement. However, operation of the HWR at reduced capacity would potentially reduce the volume of cooling water discharges and may result in fewer aquatic resource impacts. The MHTGR or ALWR-related aquatic resource impacts would not change from the baseline tritium production requirement consequences since the reactor would operate at the same level to maintain power levels for stream or electrical production. Construction and operation of a Phased APT would have similar aquatic resource impacts but potentially slightly less than the Full APT.

*Potential Mitigation Measures.* Impacts to aquatic resources could be mitigated by implementing a soil erosion and sediment control plan to reduce stream turbidity. Also, the use of discharge detention basins and energy dissipating structures could prevent excessive increases in the rate of stream flows. Intake structures could also be designed and operated to reduce intake flow rates, thereby reducing impingement and entrainment losses. All discharges would be required to meet NPDES and Tennessee *Water Quality Control Act* requirements.

**Threatened and Endangered Species.**

*No Action.* Under No Action, the missions described in section 3.3.3 would continue, with no change in impacts to threatened and endangered species at ORR.

*Tritium Supply and Recycling.* Impacts to threatened and endangered species resulting from construction of the HWR, MHTGR, ALWR, or APT would vary by the amount of terrestrial habitat disturbed (table 4.4.3.6–1). Federal-listed threatened and endangered species are not expected to be affected by construction activities. Although the Indiana and gray bats are potential resident species, neither is known to occur on ORR. Land-clearing activities may destroy state-protected plant species found within or adjacent to disturbed portions of the proposed site including pink lady's-slippers and fen orchid (state, endangered), tubercled ren-orchid, ginseng, purple fringeless orchid, and Canada lily (state, threatened). The Tennessee dace is sensitive to siltation and actively seeks clean gravel for spawning. An increase in amount or duration of sediment runoff to Ish Creek or Bear Creek during facility construction could adversely impact this fish species (OR DOE 1992e). Construction could also impact four state-listed bird species. The Cooper's hawk and sharp-shinned hawk (both threatened) would lose potential nesting and foraging habitat as a result of the construction of the facility. The red-shouldered hawk and black vulture, both deemed in need of management by the state, would also lose habitat. Preactivity surveys would be required prior to construction to determine the occurrence of these species in the area to be disturbed. During operation, the high velocity and large volume of cooling system blowdown discharge to surface water could alter the aquatic ecology of East Fork Poplar Creek and disrupt hellbender habitat.

Construction and operation of a tritium supply facility alone would result in similar impacts to threatened and endangered species but slightly less than those described for a collocated tritium supply and recycling facility. This is the case since both land and water requirements would be less.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would be expected to result in similar impacts to threatened, endangered or sensitive species as described for the baseline tritium production requirement. Construction and operation of a Phased APT would also have similar impacts to these species.

*Potential Mitigation Measures.* Disturbance of threatened, endangered, and special status species would be avoided where possible. Land clearing could be avoided during the nesting season of protected bird species. Where appropriate, habitat restoration or propagation programs could be attempted for protected plants when their disturbance is unavoidable. Use of the Clinch River for wastewater discharge would avoid impacting hellbender habitat. Detention ponds and other alternative cooling system blowdown release mechanisms described in section 4.4.3.4 could be used to prevent increasing the rate of stream flow.

Consultation with the USFWS would be pursued as required and, if necessary, a detailed plan to mitigate impacts to Federal-listed threatened and endangered species at ORR would be developed. Currently, no critical habitat has been designated for threatened and endangered species at ORR.

#### 4.4.3.7 *Cultural and Paleontological Resources*

Cultural and paleontological resources may be affected directly through ground disturbance during construction, visual intrusion of the project to the historic setting or environmental context of historic sites, visual and audio intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Intensive cultural resources inventories and site evaluations have not been conducted for the proposed TSS. Site-specific surveys and evaluations would be conducted in conjunction with tiered NEPA documentation. Although the location and acreage for the proposed tritium supply plant or combined tritium supply and recycling facilities will vary, the effects on cultural and paleontological resources are based primarily on the amount of ground disturbance; therefore, the facilities with the greatest ground disturbance will have the greatest effect on cultural and paleontological resources. Some NRHP-eligible prehistoric and historic sites and some important Native American sites may be affected by the proposed action. Effects to paleontological resources will be negligible.

**Prehistoric and Historic Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at ORR. Any impacts to prehistoric and historic resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Land disturbance for the proposed tritium supply facility (section 3.4) would range from 360 acres for the MHTGR 173 acres for the APT at ORR (section 4.4.3.1). Acreages for the HWR and ALWR would be 260 and 360, respectively. Acreage required by the recycling facilities would be an additional 196 acres. Although an intensive survey has not yet been conducted, some NRHP-eligible prehistoric and historic sites may occur within acreages that would be disturbed during construction. The prehistoric sites may include small camps and limited activity locations; the historic sites may include remains of farmsteads, roads, and trash scatters. NRHP-eligible resources will be identified through project-specific inventories and evaluations, and any project-related effects would be addressed in tiered NEPA documentation. Operation of new tritium facilities does not involve additional ground disturbance or increased activity; therefore, prehistoric or historic sites would not be affected.

*Less Than Baseline Operations.* No change in impacts to prehistoric and historic resources would be expected from operating the HWR at reduced capacity. Impacts for the MHTGR or ALWR would also not change from those described for the baseline tritium requirement because the MHTGR or ALWR would not be a reduced size or operate at reduced capacity.

Construction and operation of the Phased APT would not change the expected impacts from the baseline tritium requirement sized technologies since the disturbed area would be the same.

*Potential Mitigation Measures.* If NRHP-eligible resources cannot be avoided through project design or siting, and would result in an adverse effect, then a Memorandum of Agreement would need to be negotiated between DOE, the Tennessee SHPO, and the Advisory Council on Historic Preservation describing and implementing intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs. The appropriate level of data recovery for mitigation would be determined through the Tennessee SHPO and the Advisory Council on Historic Preservation, in

accordance with Section 106 of the *National Historic Preservation Act.*

**Native American Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at ORR. Any impacts to Native American resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Native American resources may occur within the acreages that would be disturbed during construction of the tritium supply plant or combined tritium supply and recycling facilities. Native American resources may include villages, cemeteries, burials, and traditional plant gathering areas. Operation of tritium facilities may create audio or visual intrusions on Native American sacred sites in the vicinity or reduce access to traditional use areas. Specific concerns about the presence, type, and locations of Native American resources would be identified through consultation with the potentially affected Native American groups, and any project-related effects would be addressed in tiered NEPA documentation.

*Less Than Baseline Operations.* Impacts to Native American resources would not change due to less than baseline tritium operation of the HWR, MHTGR or ALWR. Construction and operation of a Phased APT would have similar impacts on Native American resources as those described for the baseline tritium requirement Full APT.

*Potential Mitigation Measures.* If Native American resources cannot be avoided through project design or siting, acceptable mitigation measures to minimize the effect on these resources would be determined in consultation with the potentially affected Native American groups. Such mitigations may include, but not be limited to, appropriate relocation of human remains according to the *Native American Graves Protection and Repatriation Act*, planting vegetation screens to reduce visual and noise intrusions, increased access to traditional use areas during operations, or transplanting or harvesting sensitive Native American plant resources.

**Paleontological Resources.** Fossiliferous geological formations with surface exposures occur within the proposed area designated for the tritium supply and recycling facilities. All known paleontological materials consist of relatively common and widespread invertebrate fossils and these assemblages have relatively low research potential. Consequently, while there may be effects on paleontological resources, impacts would be negligible.

*Less Than Baseline Operations.* No change in impacts to paleontological resources would be expected due to reduced operation of the HWR, MHTGR or ALWR. Construction of a Phased APT may potentially have a slightly smaller impact on paleontological resources due to less excavation for APT tunnel length.

#### 4.4.3.8 *Socioeconomics*

Locating any of the tritium supply technologies alone or with recycling facilities at ORR would affect socioeconomics in the region. Section 3.2 provides descriptions for No Action, the tritium supply technologies, and tritium recycling. Siting a tritium supply technology and recycling facility at ORR would create changes in some of the communities in both the ROI and the economic study area. The in-migrating population could increase the demand for housing units. Additionally, there would be an associated increased burden on community infrastructure and subsequent effects on the public finances of local governments in the ROI. The increase of population could also burden transportation routes in the ROI.

The ALWR at ORR would create the greatest changes during construction, but the HWR, MHTGR, and ALWR would result in similar changes during operations. The APT would cause the fewest changes of the tritium supply technologies. None of these tritium supply technologies would increase population, the need for additional housing, or local government spending in the ROI beyond 3 percent over No Action during peak construction or operation. Although the greatest percent increases in employment, population and housing, and public finance during construction and operation occur in the peak years of 2005 and 2010, respectively, the annual average increases over the periods for construction (2001 to 2005) and peak construction to full operation (2005 to 2010) are between less than 1 percent and 2 percent average growth annually, and 1 percent average annual growth during operation (2010 to 2050). None of the annual average increases associated with tritium supply technologies and recycling facilities constitutes a major difference from the No Action annual average increases.

The effects of locating any of the tritium supply technologies alone or with recycling facilities at ORR are summarized in section 4.4.3. The following sections describe the effects that locating one of these technologies would have on the local region's economy and employment, population, housing, public finances, and local transportation.

**Employment and Local Economy.** Changes in employment and levels of economic activity in the 29-county economic study area from the proposed action at ORR are described in this section. Although specialized personnel, materials, and services required for construction and operation would be imported from outside the area, a significant portion of these requirements would be available in this economic study area. Figures 4.4.3.8–1 and 4.4.3.8–2 present the potential changes in employment and local economy that would occur with each of the technologies.

*No Action.* Under No Action, employment at ORR was approximately 15,000 persons in 1994. This is a decrease of approximately 300 persons from the 1990 employment. ORR employment is projected to remain at 15,000 persons through 2020. Historical and future employment projections at ORR are found in appendix table D.2.1–1. The total ORR payroll was approximately $513 million in 1994 and is expected to remain at this level through 2010.

Total employment in the economic study area is projected to grow less than 1 percent annually between 2001 and 2009, reaching 570,500 persons, and decrease less than 1 percent annually between 2010 and 2020, reaching 565,200 persons. The unemployment rate in the economic study area is expected to remain at 6.2 percent between 2001 and 2020. Per capita income is projected to increase from $17,900 to $20,700 during this 20-year period. No Action estimates are presented in appendix table D.3–38.

*Tritium Supply and Recycling.* Construction activities would begin between the years 2001 and 2003 and would be completed between the years 2007 and 2009. Phasing in of employment for the operation of the new facilities would begin in the year 2007 or 2008, peak at full employment by the year 2010, and continue at this level into the future.

Locating any of the tritium supply technologies and recycling facilities at ORR would create new jobs (direct) at the site. Indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new jobs. The total new jobs (direct and indirect) created would reduce unemployment and increase income in the economic region surrounding ORR during both the construction and operation periods of the proposed action.

Construction. Locating tritium supply and recycling facilities at ORR would require a total of approximately 4,400 to 13,600 worker-years of activity over a 5- to 9-year construction period. This construction-related employment would indirectly create other jobs in the economic study area and total employment would grow at an annual average rate of 1 percent until the peak year of 2005. Between 2005 and 2010, annual growth would slow to less than 1 percent. Figure 4.4.3.8–1 gives the estimates of total jobs (direct and indirect) that would be created during peak construction (year 2005) for each of the tritium supply technologies with recycling and the recycling facility's contribution to employment growth.

As employment opportunities grow in the economic study area due to the proposed action, the unemployment rate would be reduced from the No Action estimate of 6.2 percent. Figure 4.4.3.8–2 presents a comparison of unemployment rates for the different tritium supply technologies and recycling facilities during peak construction in the year 2005. During the project's peak construction phase, the unemployment rate would range from a high of 5.5 percent to 4.8 percent, depending upon the tritium supply technology with recycling selected.

Income in the economic study area would also increase slightly, particularly during peak construction as shown in figure 4.4.3.8–2. Per capita income is expected to increase at an annual average of 1 percent until the peak construction year (2005). Between 2005 and 2010, per capita income is also expected to increase annually by 1 percent. This is the same increase that is projected for the No Action per capita income for the same time periods.

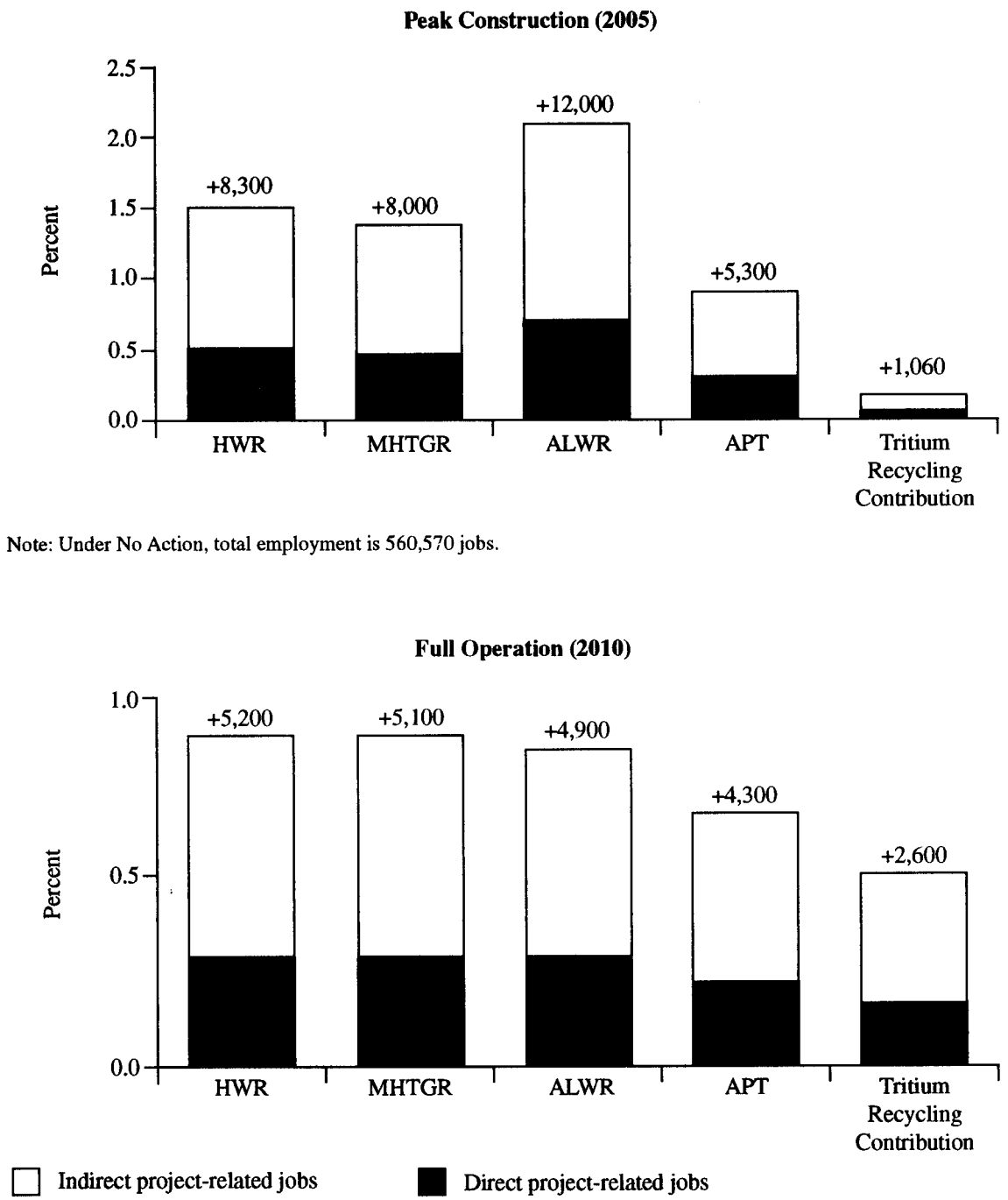
Operation. Siting tritium supply and recycling facilities at ORR would help offset the employment and income losses at ORR from the approximately 300 jobs lost between 1990 and 1994. Employment for operation would begin phasing in as construction nears completion and the construction-related employment begins phasing out. It is expected that full operation employment would peak in the year 2010 and continue at this level into the future. Figure 4.4.3.8–1 gives the total project-related jobs projections (direct and indirect) for each of the tritium supply technologies and recycling facilities for the year 2010. Total employment would be flat from 2010 to 2020; the same is projected under No Action.

Creation of additional job opportunities would reduce the unemployment rate below that projected for No Action. Figure 4.4.3.8–2 presents the differences in unemployment rates during the first year of full operation employment (2010) for each of the tritium supply technologies and recycling facilities. From the years 2010 to 2020, unemployment would be reduced from the No Action projection of 6.2 percent to between 5.6 and 5.7 percent, depending upon the technologies selected for the proposed action.

Income would also increase slightly in the economic study area as a result of the proposed action. Per capita income differences for tritium supply technologies and recycling facilities for the year 2010 are given in figure 4.4.3.8–2. Per capita income annual average increases would be about 1 percent between the years 2010 to 2020 for the different tritium supply technologies and recycling facilities considered for location at ORR. The No Action projected annual average increase during the same period would also be approximately 1 percent.

*Tritium Supply Alone.* Construction of the tritium supply technologies without recycling facilities would begin between 2001 and 2003 and would be completed between 2007 and 2009. Employment for the operation of the facility would begin in the year 2007 and reach full employment by 2010. Locating any of the tritium supply technologies at ORR would create new jobs at the site and indirectly create other jobs in the region. However, this job creation and the additional economic effects would be less than the effects that would occur with the collocation of tritium supply with the recycling facility.

Construction. Construction of tritium supply technologies would require a total of 3,400 to 12,600 worker-years of activity over a 5- to 9-year period. New jobs would be created, but this employment growth would be less than 1 percent over No Action estimates. Appendix table D.3–39, presents the estimates of total employment during peak construction in 2005, or these new jobs can be calculated by subtracting the tritium recycling contribution from tritium supply technologies and recycling in figure 4.4.3.8–1.




Note: Under No Action, total employment is 560,570 jobs.

Note: Tritium supply technologies include recycling. To calculate supply only, subtract tritium recycling contribution. Under No Action, total employment is 573,000 jobs. The percent increase in total employment during peak construction and operation was calculated by dividing the total project-related jobs by the total employment under No Action.

Source: Appendix table D.3–40.

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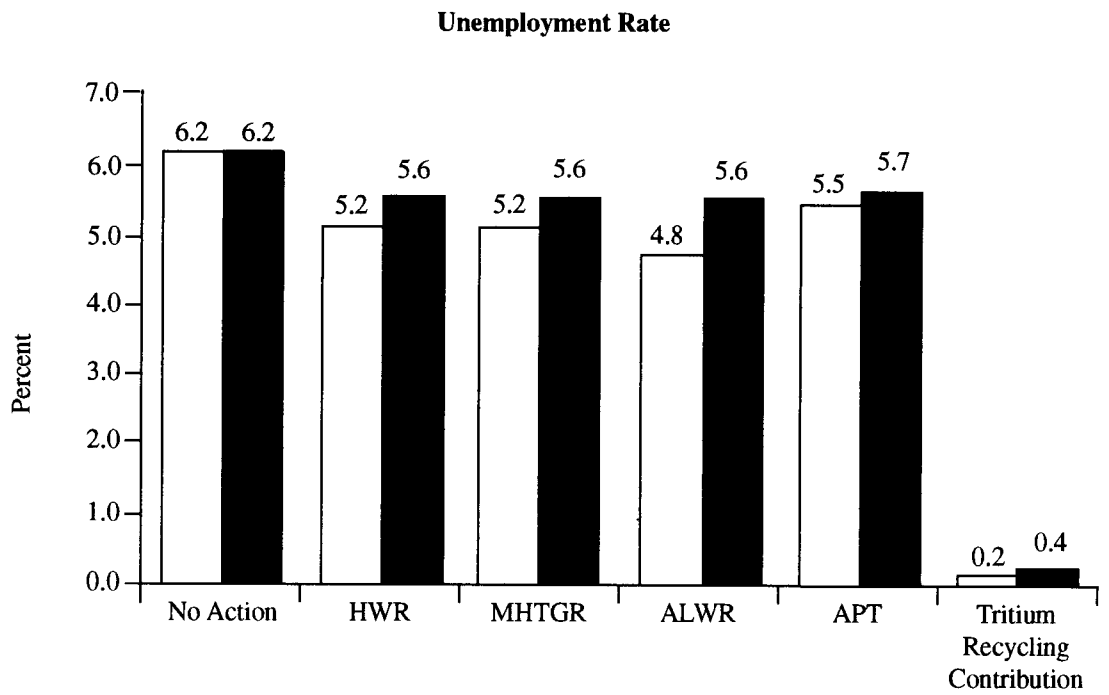
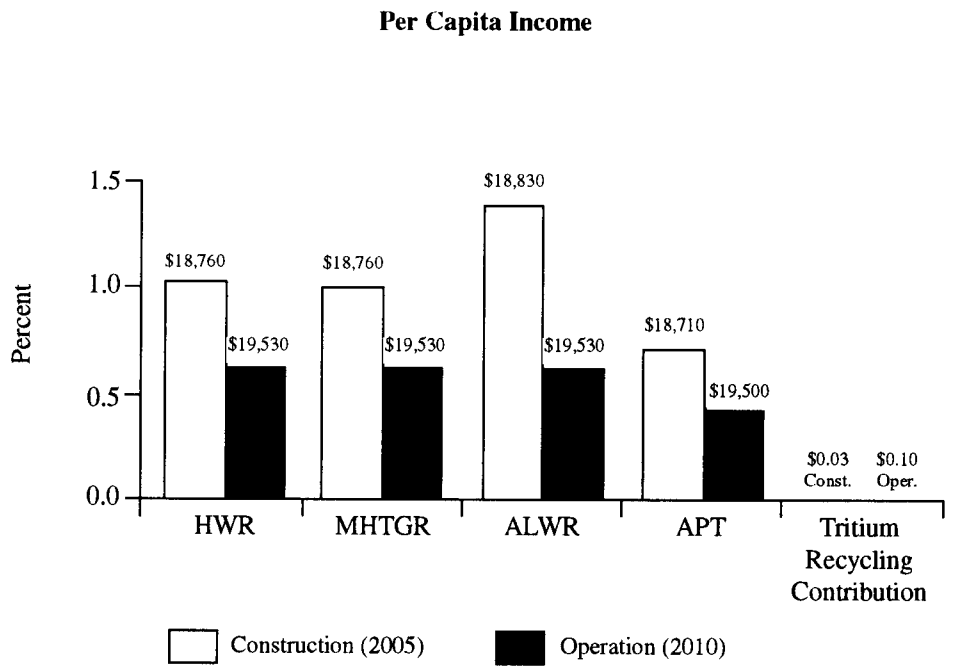
**FIGURE 4.4.3.8–1.—*Total Project-Related Employment (Direct and Indirect) and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Economic Study Area.***




Note: Under No Action, per capita income is projected to be $18,750 in 2005 and $19,510 in 2010.

Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution.

Appendix table D.3–40.

**FIGURE 4.4.3.8–2.—*Unemployment Rate, Per Capita Income, and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Economic Study Area.***

Although the construction of the facility will create new jobs, the effects would not be enough to greatly affect the unemployment rate projected for No Action. Additionally, per capita income in the region would rise only slightly above that estimated for No Action. Estimates of unemployment rate and per capita income are presented in appendix table D.3–39, or can be derived for tritium supply technologies by subtracting the tritium recycling contribution in figure 4.4.3.8–2.

Operation. Operation employment for the tritium supply technologies alone would begin phasing in at the end of the construction period and be at full employment in the year 2010. Full employment is expected to be maintained for the life of the facility. Estimates for full employment in 2010 are presented in appendix table D.3–39. Total project related jobs created by the tritium supply technologies alone can be calculated by subtracting tritium recycling contribution in figure 4.4.3.8–1.

The addition of new jobs during operation would reduce the unemployment rate below the projection for No Action. The unemployment rate for 2010, the first year of full operation employment, is presented in appendix table D.3–39, or can be calculated by subtracting the tritium recycling contribution in figure 4.4.3.8–2. Unemployment would be reduced from the No Action projection of 6.2 percent to between 6.0 and 5.9 percent during the years 2010 to 2020, depending on the technology selected.

The creation of new jobs as a result of tritium supply operation would also increase income slightly over the No Action estimates. Appendix table D.3–39, gives the per capita income for the facility for the year 2010. Per capita income growth can also be calculated by subtracting the tritium recycling contribution in figure 4.4.3.8–2. During the years 2010 to 2020, per capita income annual increases would be 1 percent, the same annual increase projected under No Action.

*Less Than Baseline Operations.* Tritium supply technologies that provide less than the baseline tritium operation capacities are described in section 3.1. These options may or may not be collocated with the tritium recycling facilities. The options include lowering the power in the HWR, using fewer target rods in the MHTGR or ALWR, and the phased approach for the APT.

Construction. The less than baseline operations case for the HWR, MHTGR, and ALWR would have the same construction workforce requirements as discussed in the tritium supply and recycling and tritium supply only sections. Therefore, employment and economic effects in the region would be the same.

The Phased APT would require the same total number of construction workers as the Full APT, but the construction period would span the years 1999 to 2008 instead of 2003 to 2007. Additionally, peak construction would occur in 2003 instead of 2005. The effects on the economic study area's employment, unemployment rate, and per capita income as a result of constructing the Phased APT are presented in appendix table D.3–39. Appendix table D.3–40, presents the effects on employment, unemployment rate, and per capita income for constructing the Phased APT with tritium recycling facilities. Generally, average annual increases in employment and income are similar to those for the Full APT, but these increases are over a longer period of time. These increases are less than or equal to 1 percent, the same as the No Action estimates.

Operation. Operation workforce requirements for the less than baseline tritium requirement case for the HWR, MHTGR, ALWR, and the Phased APT would be the same as those described in the tritium supply and recycling and tritium supply only sections. Thus, regional employment and economic effects would be the same.

**Population and Housing.** Changes to ROI population and housing expected from the proposed action at ORR are described in this section. Additional population could be expected to in-migrate to the ORR region and these people would be expected to reside in cities and counties within the ROI in the same relative proportion as the existing population. Increases to population could lead to a demand for additional housing units beyond existing vacant housing available during construction or operation phases of the proposed action. Figures 4.4.3.8–3 and 4.4.3.8–4 present the changes in population and housing for the tritium supply technologies and recycling facilities.

*No Action.* Population and housing annual average increases between 2001 and 2009 are projected to be 1 percent. Future annual average increases are projected to be less than 1 percent between 2010 and 2020. Population in the ROI is estimated to reach 561,000 in 2010 and 586,000 in 2020. Total housing units in the ROI are estimated to reach 239,800 in 2010 and 250,500 in 2020. No Action estimates are presented in appendix tables D.3–41 and D.3–44.

*Tritium Supply and Recycling.* It is expected that the proposed action would increase population and housing demands in the ROI slightly (less than 1 percent) over No Action projections during peak construction. The effects are expected to be fewer (much less than 1 percent) during the operation phase of the proposed action.

Construction. Construction activities would be phased over a 5- to 9-year period. Figure 4.4.3.8–3 illustrates that during peak construction (year 2005), the ALWR would create the largest population and housing demand increases over No Action, and the APT would have the fewest effects. The increase in population could require some additional housing units beyond what is currently available in the existing housing mix. However, any requirements for additional housing units would be at annual average increases of 1 percent in the first 3 years of construction of the ALWR, followed by an increase of much less than 1 percent until peak operation. The other tritium supply technologies would have annual average population and housing demand growth of less than 1 percent. Therefore, there would not be any major effects on any of the ROI communities.

Operation. Operation of tritium supply technologies and recycling facilities is expected to reach full employment by 2010. In-migrating population is expected to demand housing units similar to the existing housing mix in the ROI. Figure 4.4.3.8–4 shows that population increases and potential demand for additional housing units over No Action projections is almost negligible (much less than 1 percent) in this peak year. Given that the operations of the proposed action would be phased in over a 4-year period, it is expected that existing vacancies would absorb much of this new demand and that No Action requirements would be exceeded by very few units.

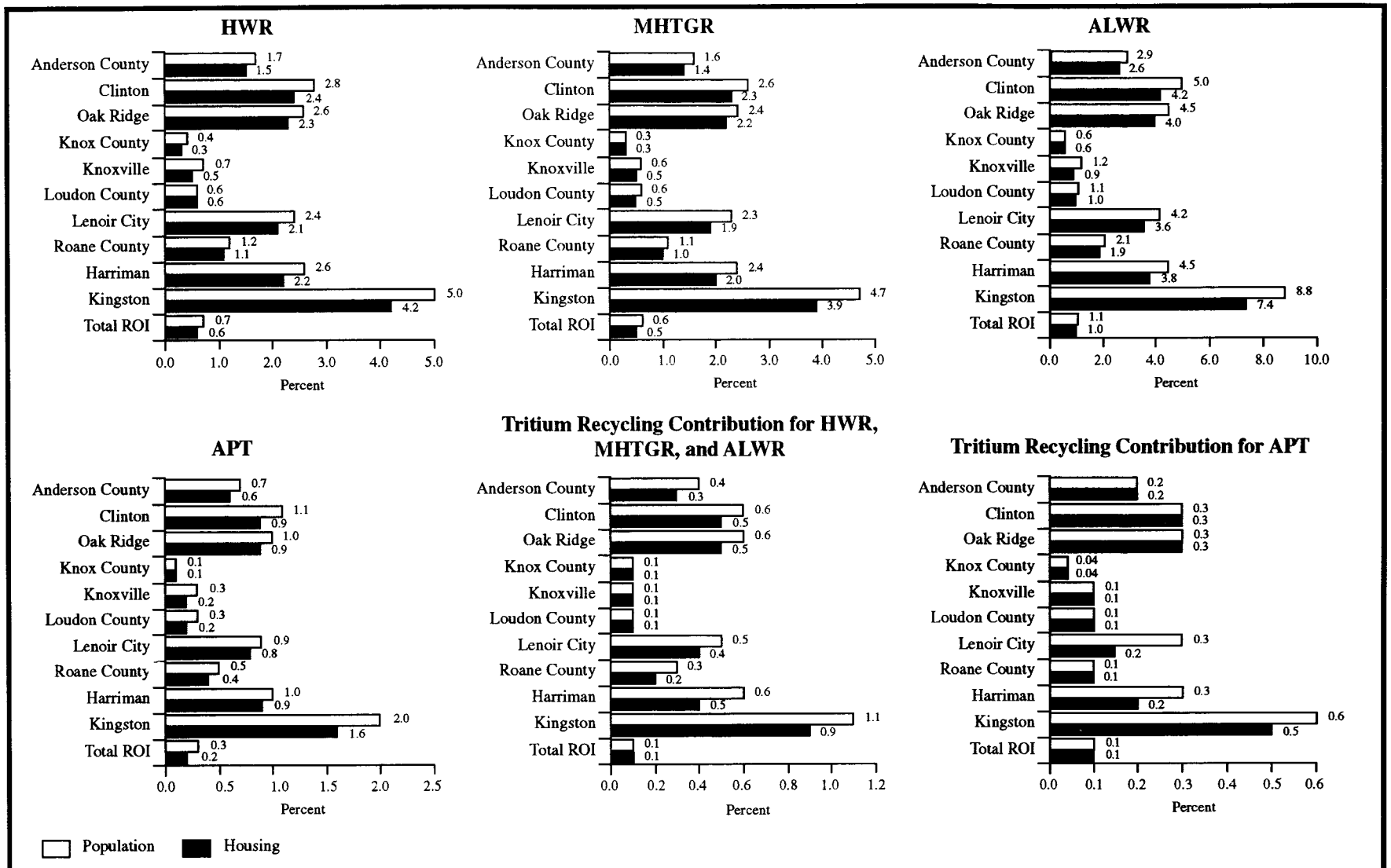
*Tritium Supply Alone.* Locating only a tritium supply technology at ORR would not increase population or housing demands in the ROI more than 1 percent over No Action projections during the construction or operation periods.

Construction. Construction activities for the tritium supply technologies alone would be much lower than if collocated with the tritium recycling facilities. The greatest increase in population and housing demand would occur during peak construction in 2005. Appendix tables D.3–42 and D.3–45, show that available vacancies in the existing housing mix would probably accommodate the expected population growth. Estimated growth in the ROI is much less than 1 percent over the No Action projection.

Operation. Full employment levels for tritium supply only would be reached by the year 2010. In-migrating population would be expected to require housing units similar to the existing mix in the ROI. These requirements would be lower than those for any of the tritium supply technologies with the recycling facilities. Potential demand for housing units would be very small (much less than 1 percent) in the first year of full employment as illustrated in appendix tables D.3–42 and D.3–45. It is expected that existing vacancies would absorb most of this new demand as employment would be phased in during the years 2007 through 2010.

*Less Than Baseline Operations.* Population increases and housing demands would be the same or lower during construction and operation of tritium supply technologies operated at less than baseline tritium requirements than the alternatives discussed in the tritium supply and recycling and tritium supply only sections.

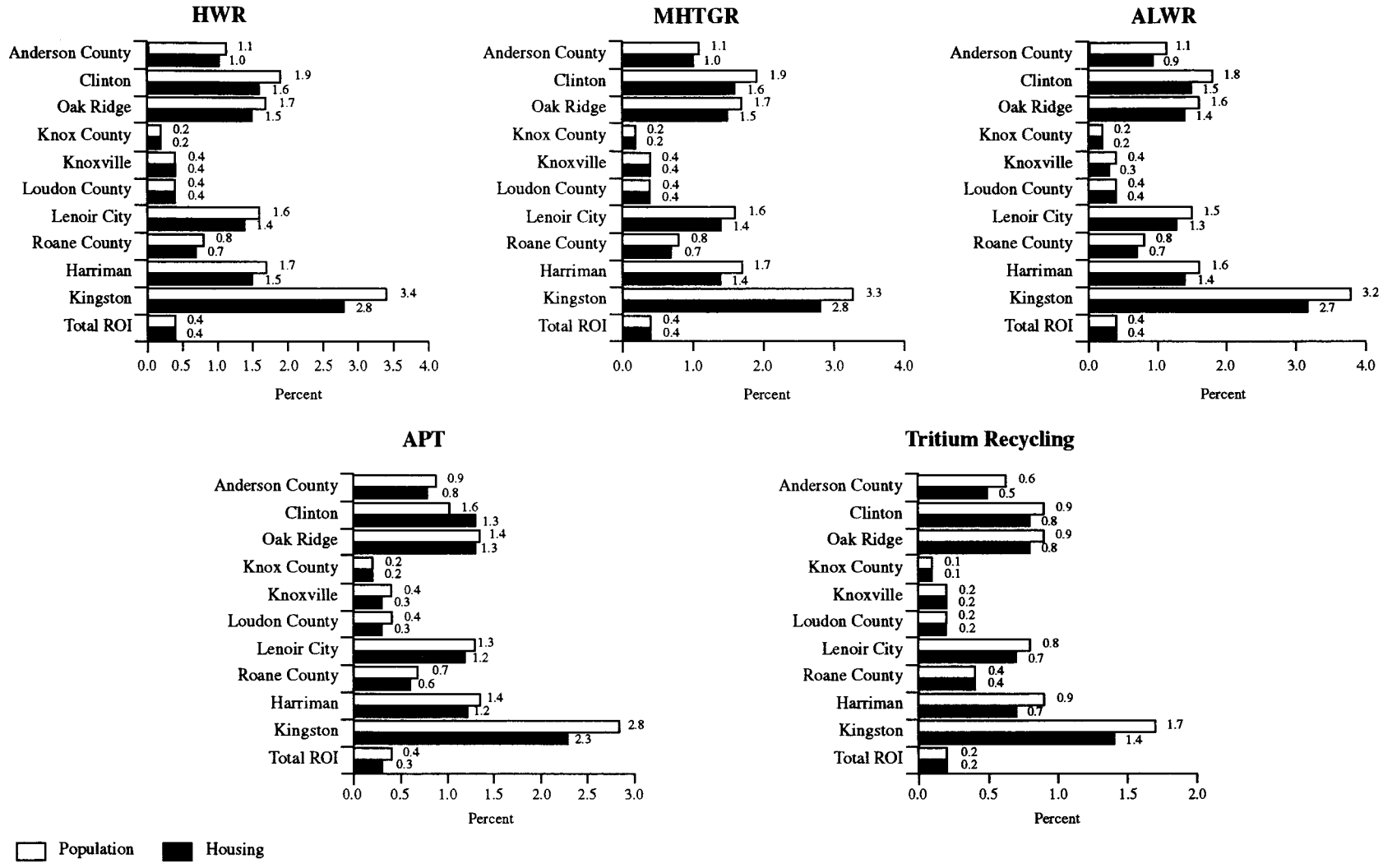
Construction. Population increases and housing demands would be the same as those given in figure 4.4.3.8–3 for the HWR, MHTGR, and ALWR. The Phased APT would increase population and housing demand during construction to the same level as the Full APT, but this would occur over a longer construction period with lower average annual increases. Also, the peak construction year would be 2003 instead of 2005. The effects of the Phased APT on population and housing are presented in appendix tables D.3–42 and D.3–45, respectively. Appendix tables D.3–43 and D.3–46, present the results of




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–42, D.3–43, D.3–45, and D.3–46.

Source: Appendix tables D.3–43; D.3–46.

**FIGURE 4.4.3.8–3.—*Total Population and Housing Percentage Increase Over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–43 and D.3–46.

Source: Appendix tables D.3–43; D.3–46.

**FIGURE 4.4.3.8–4.—*Total Population and Housing Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence, 2010.***

constructing the Phased APT with the tritium recycling facilities.

Operation. The effects on population and housing of operating the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirement would be the same as those given in figure 4.4.3.8–4.

**Public Finance.** Fiscal changes could occur in some ROI local jurisdictions from the proposed action. Factors influencing these changes include residence of project-related employees and their dependents, cost and duration of construction, and economic conditions in the ROI once the new facilities are operational.

Implementing the proposed action at ORR would increase population, resulting in more revenues for ROI local jurisdictions. Additional population would also increase public service expenditures.

Figures 4.4.3.8–5 and 4.4.3.8–6 present the potential fiscal changes that would occur with the different tritium supply technologies and recycling facilities.

*No Action.* Appendix table D.3–47, presents the 1992 public finance characteristics for the local ROI jurisdictions. Appendix tables D.3–48 through D.3–51, present the impacts from tritium supply technologies with or without recycling facilities compared to No Action during construction and operation for the local counties and cities. Funding for school districts is included in the finances for the county or city in which they are found. Between 2001 and 2005, all ROI counties and cities are projected to increase total revenues on an annual average of 1 percent or less. Total expenditures are projected to increase on an annual average of 1 percent or less for most ROI counties and cities between 2001 and 2005. Between the peak year of construction (2005) and full operation (2010), total revenues and expenditures are also expected to increase by less than 1 percent.

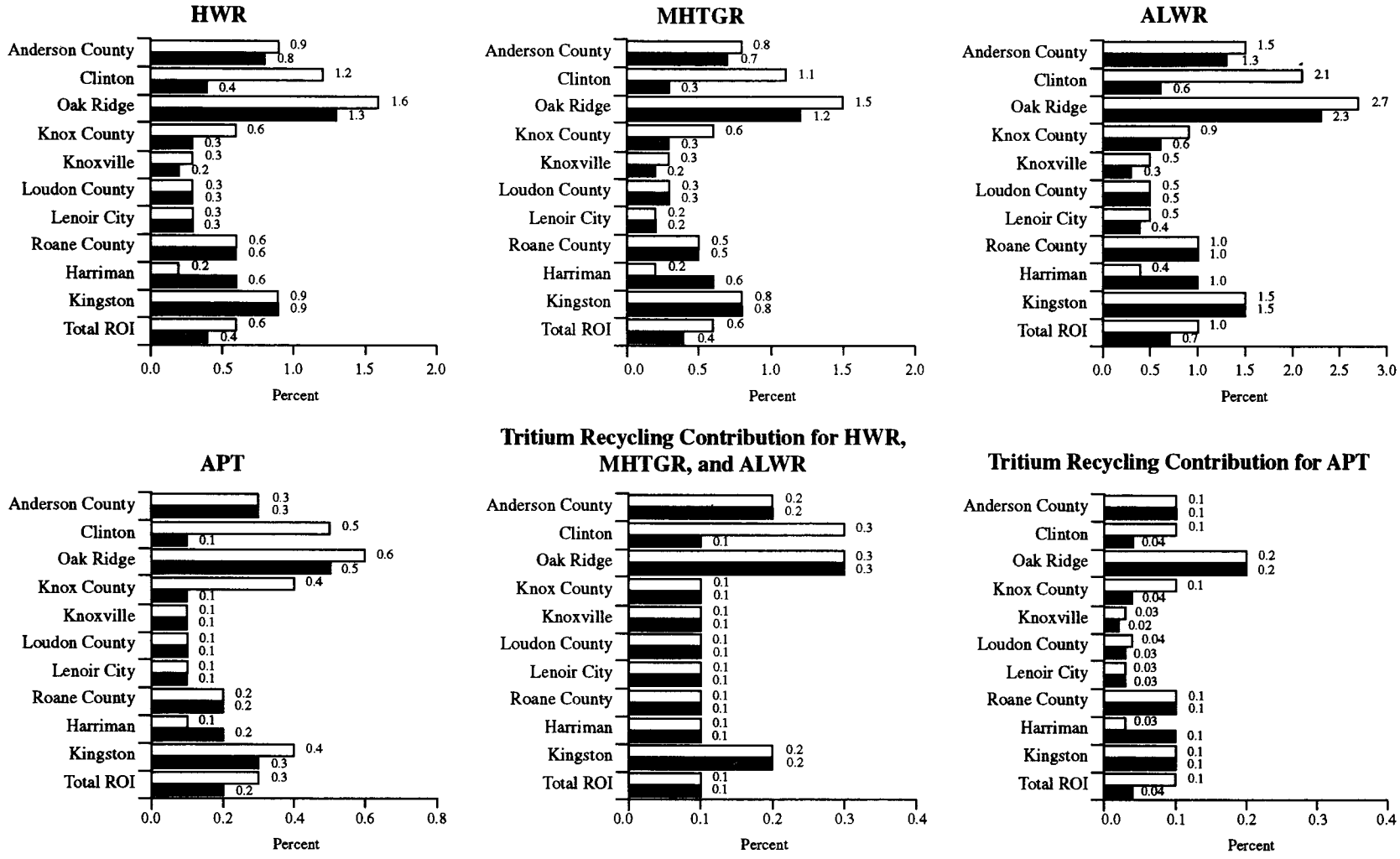
Between 2010 and 2020, projected annual average increases in total revenues are less than 1 percent for all counties and cities in the ROI. Total expenditures are also projected to increase on an annual average by 1 percent or less for ROI jurisdictions between 2010 and 2020.

*Tritium Supply and Recycling.* The proposed action at ORR would create some fiscal benefits to local jurisdictions within the ROI. Some local government finances would be affected during the construction and operation phases of the proposed action. Construction-related effects on revenues and expenditures could span a period of 5 to 9 years with the peak occurring in 2005. The effects of the operation phase would peak in 2010 and remain at this level throughout the life of the proposed action.

Construction. The public finances of counties and cities within the ROI would be affected by the construction-related activities associated with the proposed action. Initially, there would be slight increases to some local government jurisdictions' revenues and expenditures, which would peak in the year 2005 and then decline as construction neared completion. Figure 4.4.3.8–5 presents the revenue and expenditure changes of ROI local government jurisdictions over No Action during peak construction for the four tritium supply technologies and recycling facilities. Over the construction phase of the proposed action and between 2005 to 2010, revenues and expenditures for ROI counties and cities would increase on an annual average of 1 percent or less for all the tritium supply technologies with recycling facilities. Under the No Action estimates, local government revenues and expenditures would also increase on an annual average of 1 percent or less.

Operation. The effects of phasing in operation together with the phasing out of construction on ROI local government finances would be fewer than the effects at peak or full operation (year 2010). The effects that the four tritium supply technologies and recycling facilities would have on county and city revenues and expenditures are presented in figure 4.4.3.8–6. Between 2010 and 2020, revenues and expenditures are expected to increase slightly but at an average annual rate of less than 1 percent for all ROI jurisdictions. The No Action local government revenues and expenditures would also increase at an average annual rate of less than 1 percent.

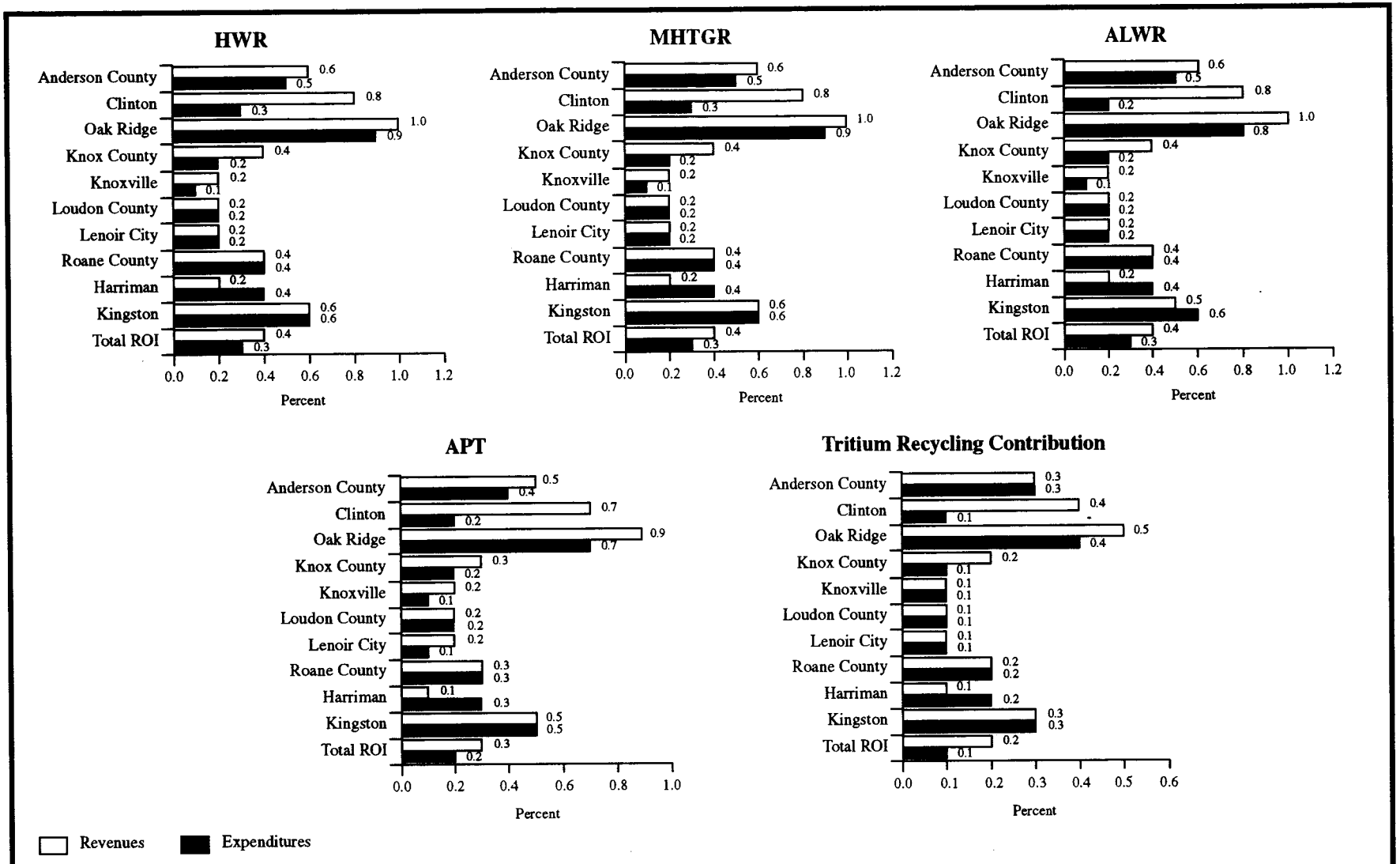
*Tritium Supply Alone.* Locating the tritium supply alone at ORR would create some fiscal benefits to local jurisdictions within the ROI, but these benefits




Note: Revenue and expenditure values are in thousands of dollars. Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete county and city breakdown of revenues and expenditures, see appendix tables D.3–48 and D.3–50.

Source: Appendix table D.3–50.

**FIGURE 4.4.3.8–5.—*County, City, and School District Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete county and city breakdown of revenues and expenditures, see appendix tables D.3–49 and D.3–51.

Source: Appendix table D.3–51.

**FIGURE 4.4.3.8–6.—*County, City, and School District Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence, 2010.***

would be fewer than if collocated with the recycling facilities.

Construction. Construction-related effects on the revenues and expenditures of counties and cities would be annual average increases of less than 1 percent until peak construction (2005) and between 2005 and 2010. Appendix table D.3–48, presents the revenue and expenditure changes of ROI local governments over No Action during peak construction of the tritium supply technologies alone.

Operation. The operation phase of the tritium supply only would affect the public finances of counties and cities in the ROI but these effects would be less than those resulting from operating the tritium supply technologies with the recycling facilities. Appendix table D.3–49, presents the effects that operation would have on these local jurisdictions in the year 2010. During the years 2010 to 2020 revenues and expenditures are expected to increase annually by less than 1 percent. In comparison, No Action local government revenues and expenditures would increase at an average annual rate of 1 percent.

*Less Than Baseline Operations.* The fiscal benefits that local jurisdictions would accrue from the location of a tritium supply technology alone or collocated with recycling would be the same or less if the tritium supply technologies were operated at less than baseline tritium requirements.

Construction. Increases in local jurisdictions' revenues and expenditures would be the same as those given in figures 4.4.3.8–5 and 4.4.3.8–6 if the HWR, MHTGR, or ALWR, are built. If the Phased APT were constructed, the effects would peak in the year 2003 instead of 2005, and the annual average increases would be lower. Appendix tables D.3–48 and D.3–49 present the revenue and expenditure changes as a result of constructing the Phased APT for all ROI jurisdictions. Revenue and expenditure changes resulting from the construction of the Phased APT with tritium recycling are presented in appendix tables D.3–50 and D.3–51.

Operation. Operation of the HWR, MHTGR, ALWR, and Phased APT at less than baseline tritium requirements would have the same effects on local jurisdictions' finances as those presented in figure 4.4.3.8–6.

**Potential Mitigation Measures.** Adding new missions to ORR would create new jobs and generally benefit the local economy through increased earnings in the ROI. Some mitigation measures may be required, such as Federal aid to local school districts where additional school age children would attend as a result of the proposed action. These new missions at ORR would increase population and the demand for additional housing units. Temporary housing units and mobile homes would help to alleviate the demand for new housing during the construction phase of the proposed action. Generally, construction would be phased over a period of 5 to 9 years with peak construction occurring in the year 2005. Phasing the start of operation employment and training between 2005 and 2010 would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

**Local Transportation.** The following is a description of the effects on local transportation resulting from locating new missions at ORR. Construction and operation of a tritium supply technology and recycling facilities are expected to increase traffic flow on site access routes.

*No Action.* Under No Action, the worker population at ORR would not increase. Therefore, any increases in traffic would not be the result of DOE-related activities at ORR. Access to the nearest interstate highway is 10 miles via 2- and 4-lane roads that pass through rural and mountainous areas. Traffic conditions on site access roads would remain as described in section 4.4.2.8.

*Tritium Supply and Recycling.* The proposed action at ORR would result in increases, depending on the tritium supply technology, of worker population at the site. Traffic conditions on site access roads leading to and from ORR would worsen due to increased traffic volume. The primary access route to ORR is Bear Creek Road. This route would carry the greatest increase in traffic volume from site development. Locating the ALWR or MHTGR at ORR would have the greatest effect on traffic volume and flow.

*Tritium Supply Alone.* Locating a tritium supply without the recycling facility at ORR would result in

increased worker population and traffic. However, the effects on traffic volume would be less than those from siting the tritium recycling facility with any one of the supply technologies.

*Less Than Baseline Operations.* The effects on traffic volume and flow would be the same whether or not the HWR, MHTGR or ALWR were operated at baseline or less than baseline tritium requirements. Construction of the Phased APT would increase traffic volume and flow during the construction phase but less than the Full APT.

*Potential Mitigation Measures.* Mitigation of traffic conditions may be necessary due to the proposed action. Mitigation could include the widening and extension of Bear Creek Road, the primary access route to ORR, as well as possible realignment of roadways and construction of interchanges at roadway intersections overburdened by increased vehicle traffic and congestion.

### 4.4.3.9 *Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents*

This section describes the radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or accidents at facilities involved with the tritium supply and recycling facilities at ORR. The section first describes the impacts from normal operation followed by a description of impacts from facility accidents.

During normal operation at ORR, all tritium supply technologies and recycling facilities would result in impacts that are within regulatory limits. The risk of adverse health effects to the public and to workers would be small.

For facility accident impacts, the results indicate that for all tritium supply technologies and recycling facilities the risk of fatal cancers (taking into account both the probability of the accident and its consequences) from an accidental release of radioactive or hazardous chemical substances at ORR is low when compared to fatal cancers from all causes, even for a severe accident.

The impact methodology is described in section 4.1.9. Summaries of the radiological and chemical impacts associated with normal operation are presented in tables 4.4.3.9–1 and 4.4.3.9–2, respectively. Summaries of impacts associated with postulated accidents are given in tables 4.4.3.9–3 and 4.4.3.9–4. Detailed results are presented in appendix E for normal operation and in appendix F for accidents.

**Normal Operation.**

*No Action.* The current missions at ORR are described in section 3.3.3. The site has identified facilities that will continue to operate and others, if any, which will become operational by 2010. Based on that information, the radiological and chemical releases for 2010 and beyond were developed and used in the impact assessments.

Radiological Impacts. As shown in table 4.4.3.9–1, No Action would result in a calculated annual dose of 17 mrem to the maximally exposed member of the public, which projects to an estimated fatal cancer risk of $3.5 \times 10^{-4}$ from 40 years of total site operation. This annual dose is composed of a dose from liquid releases of 14 mrem (0.4 mrem is from drinking water; see appendix section E.2.6.1) and a dose from atmospheric releases of 3.9 mrem. Both the liquid and atmospheric doses are within radiological limits and when combined make up 5.7 percent of the natural background radiation received by the average person near ORR.

The population dose from total site operation in the year 2030 was calculated to be 57 person-rem, which projects to an estimated 1.1 fatal cancers from 40 years of total site operation. The population dose is composed of 18 person-rem from liquid releases and 39 person-rem from atmospheric releases and would be approximately 0.017 percent of the annual dose received by the surrounding population from natural background radiation.

The annual average dose to a site worker from No Action would be 17 mrem, which projects to an estimated fatal cancer risk of $2.8 \times 10^{-4}$ from 40 years of total site operation. The annual dose to the total site workforce would be 320 person-rem, which projects to an estimated 5.1 fatal cancers from 40 years of total site operation. These estimates are

**TABLE 4.4.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Oak Ridge Reservation***

| | | Tritium Supply Technologies and Recycling | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No Action | HWR[a] | MHTGR[a] | ALWR[a] | | APT[a] | | | Tritium Recycling |
| | | | | Large | Small | Full | | Phased | |
| Affected Environment | | | | | | Helium-3 Target System | SILC Target System | Helium-3 Target System | |
| **Maximally Exposed Individual (Public)** | | | | | | | | | |
| ***Atmospheric Release***[b] | | | | | | | | | |
| Dose (mrem/yr)[c] | 3.9 | 7.1 | 5.7 | 8.8 | 7.6 | 4.3 | 5.0 | 4.3 | 2.8 |
| Percent of natural background[d] | 1.3 | 2.3 | 1.8 | 2.9 | 2.5 | 1.4 | 1.6 | 1.4 | 0.92 |
| 40-year fatal cancer risk | $7.8\times10^{-5}$ | $1.4\times10^{-4}$ | $1.1\times10^{-4}$ | $1.8\times10^{-4}$ | $1.5\times10^{-4}$ | $8.6\times10^{-5}$ | $1.0\times10^{-4}$ | $8.6\times10^{-5}$ | $5.6\times10^{-5}$ |
| ***Liquid Release*** | | | | | | | | | |
| Dose (mrem/yr)[c] | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 0.0 |
| Percent of natural background[d] | 4.4 | 4.4 | 4.4 | 4.5 | 4.5 | 4.4 | 4.4 | 4.4 | 0.0 |
| 40-year fatal cancer risk | $2.7\times10^{-4}$ | $2.7\times10^{-4}$ | $2.7\times10^{-4}$ | $2.8\times10^{-4}$ | $2.8\times10^{-4}$ | $2.7\times10^{-4}$ | $2.7\times10^{-4}$ | $2.7\times10^{-4}$ | 0.0 |
| ***Atmospheric and Liquid Releases***[b] | | | | | | | | | |
| Dose (mrem/yr)[c] | 17 | 21 | 19 | 23 | 21 | 18 | 19 | 18 | 2.8 |
| Percent of natural background[d] | 5.7 | 6.8 | 6.2 | 74 | 7.0 | 5.8 | 6.1 | 5.8 | 0.92 |
| 40-year fatal cancer risk | $3.5\times10^{-4}$ | $4.2\times10^{-4}$ | $3.8\times10^{-4}$ | $4.5\times10^{-4}$ | $4.3\times10^{-4}$ | $3.6\times10^{-4}$ | $3.7\times10^{-4}$ | $3.6\times10^{-4}$ | $5.6\times10^{-5}$ |
| **Population Within 50 Miles** | | | | | | | | | |
| ***Atmospheric and Liquid Releases Year 2030*** | | | | | | | | | |
| Dose (person-mem) | 57 | 82 | 76 | 90 | 87 | 68 | 73 | 68 | 11 |
| Percent of natural background[d] | 0.017 | 0.025 | 0.023 | 0.027 | 0.026 | 0.021 | 0.022 | 0.021 | $3.3\times10^{-3}$ |
| 40-year fatal cancers | 1.1 | 1.6 | 1.5 | 1.8 | 1.7 | 1.4 | 1.5 | 1.4 | 0.22 |
| **Worker Onsite** | | | | | | | | | |
| Average worker dose (mrem/yr)[c] | 17 | 19 | 18 | 26 | 22 | 20 | 20 | 20 | 4 |
| 40-year fatal cancer risk | $2.8\times10^{-4}$ | $3.0\times10^{-4}$ | $2.9\times10^{-4}$ | $4.2\times10^{-4}$ | $3.6\times10^{-4}$ | $3.1\times10^{-4}$ | $3.1\times10^{-4}$ | $3.1\times10^{-4}$ | $6.4\times10^{-5}$ |
| Total workforce dose (person-rem/yr) | 320 | 360 | 350 | 490 | 420 | 372 | 373 | 372 | 1.6 |
| 40-year fatal cancers | 5.1 | 5.8 | 5.6 | 7.9 | 6.7 | 6.0 | 6.0 | 6.0 | 0.026 |

[a] Includes impacts from No Action facilities.
[b] The location of the maximally exposed individual varies depending on the tritium supply technology.
[c] The applicable radiological limits for an individual member of the public are 10 mrem/yr resulting from site operations for the air pathways, 4 mrem from the drinking water pathway, and 100 mrem/yr from all pathways combined (DOE Order 5400.5). The radiological limit for an individual worker is 5,000 mrem/yr (40 CFR 835).
[d] Natural background levels: to the average individual is 306 mrem/yr; to the population in the year 2030 is 329,800 person-rem.
Note: SILC - spallation-induced lithium conversion.
Note: Model results. See appendix sections E.2.2, E.2.6, and E.2.6.2.

based on the measured doses from 1989 to 1992 and projected employment levels in 2010.

Hazardous Chemical Impacts. As shown in table 4.4.3.9–2, No Action would result in a calculated HI of 0.36 and no cancer risk to the maximally exposed member of the public. The worker HI risk was calculated to be 0.26. These values are within the acceptable regulatory health limits.

*Tritium Supply and Recycling.* There will be no radiological releases during the construction of new tritium recycling facilities that are associated with all tritium supply technologies under consideration. Limited hazardous chemical releases are anticipated as a result of construction activities. However, their concentration will be within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The impacts from radiological and hazardous chemicals from each tritium supply technology considered are the summation of the impacts from the various facilities in operation for that technology. The resulting doses and potential health effects to the public and workers from each tritium supply technology are described below.

Radiological Impacts. Radiological impacts resulting from normal operation of tritium supply technology and recycling facilities considered for ORR are listed in table 4.4.3.9–1. The supporting analysis is provided in appendix section E.2.6.2.

The doses to the maximally exposed member of the public from annual site operations at ORR range from 18 mrem for both the APT with the helium-3 target and the Phased APT to 23 mrem for the Large ALWR. From 40 years of operation, the corresponding risks of fatal cancer to this individual would range from $3.6 \times 10^{-4}$ to $4.5 \times 10^{-4}$. As a result of total site operations in the year 2030, the population doses would range from 68 person-rem for both the APT with the helium-3 target and the Phased APT to 90 person-rem for the Large ALWR. The corresponding numbers of fatal cancers in this population from 40 years of operation would range from 1.4 to 1.8.

The annual dose to the total site workforce would range from 350 person-rem for the MHTGR to 490 person-rem for the Large ALWR. The corresponding annual average doses to a site worker would be 18 mrem for the MHTGR, and 26 mrem for the Large ALWR. The risks and numbers of fatal cancers among workers from 40 years of operation are included in table 4.4.3.9–1.

Based on the radiological impacts associated with normal operation, as described above, all of the tritium supply technologies and recycling facilities are acceptable for siting at ORR. All resulting doses are within radiological limits and are well below levels of natural background radiation.

**TABLE 4.4.3.9–2.—*Potential Hazardous Chemical Impacts to the Public and Workers Resulting from Normal Operations at Oak Ridge Reservation***

| Health Impact | No Action | HWR[a,b] | MHTGR[a,b] | ALWR[a,b] | APT | Tritium Recycling |
|---|---|---|---|---|---|---|
| **Maximally Exposed Individual (Public)** | | | | | | |
| Hazard Index | 0.36 | 0.36 | 0.36 | 0.38 | 0.36 | $2.5 \times 10^{-5}$ |
| Cancer risk | 0 | 0 | 0 | 0 | 0 | 0 |
| **Worker Onsite[b]** | | | | | | |
| Hazard Index | 0.26 | 0.27 | 0.32 | 0.35 | 0.26 | $4.0 \times 10^{-5}$ |
| Cancer risk | 0 | 0 | 0 | 0 | 0 | 0 |

[a] Includes impacts from No Action.

[b] To determine the contribution from any of the tritium supply technologies, subtract the tritium recycling values for the Hazard Index or the cancer risk, respectively.

c The Hazard Index for the onsite worker is computed by using the permissible exposure limit as the denominator rather than the reference concentration which is used for the maximally exposed member of the public (appendix E).

Note: Model results. See appendix table E.3.4–21.

Hazardous Chemical Impacts. Hazardous chemical impacts resulting from normal operation of various tritium supply technologies and recycling facilities at ORR are listed in table 4.4.3.9–2. Locating the HWR, MHTGR, ALWR, or APT at ORR would result in identical HIs of 0.36 and no cancer risk to the maximally exposed member of the public. The ALWR would have an HI of 0.38 and no cancer risk to the maximally exposed member of the public. The worker HIs ranged from 0.35 for ALWR to 0.26 for APT. There was no cancer risk for any of the supply technologies. All values are within regulatory health limits. For details on the derivation of the HIs and cancer risks, see appendix tables E.3.4–16 through E.3.4–19 and summary table E.3.4–21.

*Tritium Supply Alone.*

Radiological Impacts. If the tritium recycling processes were not collocated with the tritium supply, the annual dose to the maximally exposed individual would decrease by 2.8 mrem, which is 0.92 percent of the dose from natural background radiation received by the average person near ORR. The estimated risk of fatal cancer to this individual would decrease by $5.6 \times 10^{-5}$ over 40 years of total site operation.

Not collocating the tritium recycling processes at ORR would result in a decrease of 11 person-rem to the population within 50 miles in the year 2030, and 0.22 less fatal cancers over 40 years of operation.

If the tritium recycling processes were not collocated with the tritium supply, the average annual dose to an onsite worker would decrease by 4 mrem per year. In addition, the estimated risk of fatal cancer to this worker would decrease by $6.4 \times 10^{-5}$ over 40 years of site operation. Subsequently, the total annual workforce dose would decrease by 1.6 person-rem, resulting in 0.026 less fatal cancers over the 40 years.

Hazardous Chemical Impacts. If the tritium recycling processes are eliminated from all of the supply technologies at ORR, the cancer risk would not change since there is no cancer risk resulting from any options. The HIs for the public would be reduced by about 0.01 percent for any of the supply technologies and the reduction would be about the same for workers. Based on the hazardous chemical impacts associated with normal operations at ORR all values are within regulatory health limits.

*Less Than Baseline Operations.*

The normal operation radiological impacts for the HWR operating at reduced tritium production capacity to meet a less than baseline tritium operation requirement would be proportional to the level of operation (approximately 50 percent of baseline). The MHTGR or ALWR normal operation radiological impacts would not change because the reactor would maintain power requirements to produce steam or electricity.

The Phased APT is already less than the baseline tritium requirement and thus the impacts are as presently given in this PEIS.

Potential Mitigation Measures. Radioactive and hazardous chemical airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved methods could be used to remove radioactivity from the releases to the environment. Similarly, remote, automated, and robotic production methods are examples of techniques being developed which could reduce worker exposure. Substitution of less toxic/noncancer causing solvents would result in reductions of the HI and possible complete elimination of the cancer risk.

**Facility Accidents.**

*No Action.* Under No Action, the risk of accidents at ORR would be unchanged from that reported in safety documentation for existing facilities.

*Tritium Supply and Recycling.* The proposed action at ORR has the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents have been assessed for each tritium supply technology at ORR and are summarized in this section and described in more detail in appendix F. The methodology used in the assessment is described in section 4.1.9.

The potential impacts from accidents, ranging from high-consequence/low-probability to low-consequence/high-probability events, have been evaluated in terms of the number of cancer fatalities that may result. The risk of cancer fatalities has also been evaluated to provide an overall measure of an accident's impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities).

The analyses of postulated accidents for the tritium supply and recycling facilities at ORR indicate that, for the high consequence accident, the estimated risk of cancer fatalities to the public within 50 miles of the site is $4.4 \times 10^{-5}$ cancer fatalities per year (table 4.4.3.9–3). This accident risk, which corresponds with the ALWR, is low when compared to the risk of cancer fatalities each year to the same population from all other causes.

Details on the range of accidents for the tritium supply technologies and recycling facilities at ORR are presented in appendix F. Each of the technologies has been analyzed from the standpoint of identifying the consequences of design basis/operational accidents (using the GENII computer code) and beyond design basis, or severe accidents (using the MACCS computer code). The severe accident consequences are shown in table 4.4.3.9–3 for each technology. The table also shows the consequences of each accident for the population and for an individual who may be located at the site boundary. The results of the analysis indicate that the tritium supply and recycling facility with the highest severe accident consequence is the ALWR. The technology with the lowest accident consequence is the APT with the helium-3 target system. The MHTGR and APT have accident consequences that are much lower than the HWR and ALWR consequences. The tritium extraction and recycling facilities are common to all tritium supply technologies but, except for the APT, the consequences are dominated by reactor accidents. The tritium extraction accident dominates the accelerator accidents.

Figure 4.4.3.9–1 shows the number of latent cancer fatalities that may result for each technology, including tritium extraction and recycling, if a high consequence accident were to occur. Specifically, each curve in the figure shows the conditional probability (vertical axis) that the number of cancer fatalities (horizontal axis) will be exceeded if the accident occurred. The curves do not reflect the probability of the accident.

The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be reduced; recreational areas may have to be closed to visitors; and endangered species may move closer to extinction. In the region of the ORR, the natural background level of radiation (excluding radon) is 67 mrem per year. For a hypothetical design basis accidental release, the radiation levels exceeding 67 mrem per year are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $1.4 \times 10^{7}$ square meters (3,459 acres).

*Tritium Supply Alone.* The analyses of reasonably foreseeable high consequence accidents for the tritium supply facilities at ORR are presented below.

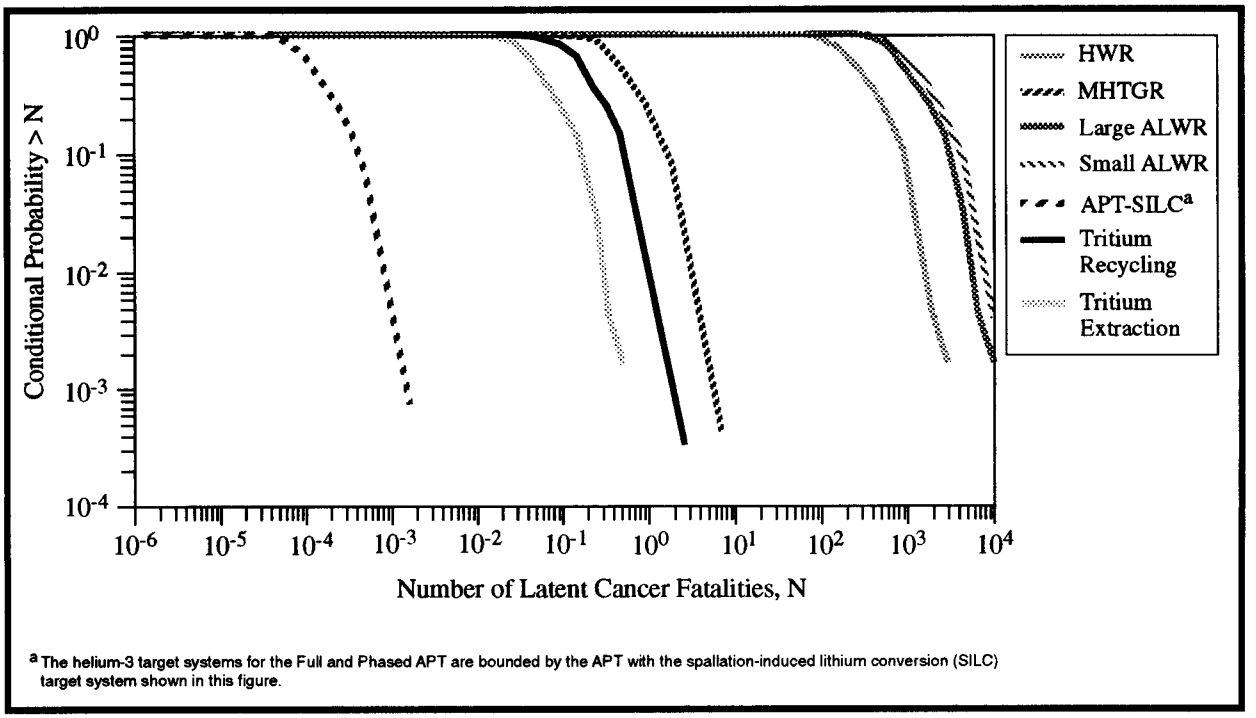
Heavy Water Reactor. A set of accident sequences with a release category in which there is a reactor isolation failure with containment spray failed was postulated as a high consequence accident for the HWR. In the event that this accident were to occur, there would be an estimated 504 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of 0.04 to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is $2.5 \times 10^{-5}$ cancer fatalities per year (table 4.4.3.9–3).

Modular High Temperature Gas-Cooled Reactor. A set of accident sequences with a release category in which there is a depressurized conduction cooldown without the reactor cavity cooling system functioning was postulated. This would be a high consequence accident for the MHTGR. In the event that this accident were to occur, there would be an estimated 0.92 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $6.8 \times 10^{-5}$ to an individual who may be located at the

**TABLE 4.4.3.9–3.—*Tritium Supply Technologies and Recycling High Consequence/Low Probability Radioactive Release Accidents and Consequences at Oak Ridge Reservation***

| | Tritium Supply Technologies and Recycling | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
| | | | Large | Small | Full/Phased | Phased | | |
| Parameter | | | | | Helium-3 Target System[f, g] | SILC Target System[h, i] | | |
| Accident/frequency (per year) | $5.0\times10^{-8}$ | $6.0\times10^{-8}$ | $2.0\times10^{-8}$ | $2.0\times10^{-8}$ | $1.0\times10^{-4}$ | $1.0\times10^{-4}$ | $1.0\times10^{-6}$ | $1.0\times10^{-6}$ |
| **Consequence** | | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | | |
| Dose (rem) | $1.3\times10^{3}$ | 2.48 | $5.1\times10^{3}$ | $5.3\times10^{3}$ | $2.6\times10^{-4}$ | $2.6\times10^{-3}$ | 0.3 | 1.0 |
| Cancer fatalities | 0.037 | $6.8\times10^{-5}$ | 0.13 | 0.16 | $5.5\times10^{-9}$ | $4.1\times10^{-8}$ | $6.5\times10^{-6}$ | $2.4\times10^{-5}$ |
| Risk (cancer fatalities per year) | $1.8\times10^{-9}$ | $4.1\times10^{-12}$ | $2.6\times10^{-9}$ | $3.2\times10^{-9}$ | $5.5\times10^{-13}$ | $4.1\times10^{-12}$ | $6.5\times10^{-12}$ | $2.4\times10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | | |
| Dose (person-rem) | $1.0\times10^{6}$ | $1.9\times10^{3}$ | $3.7\times10^{6}$ | $4.4\times10^{6}$ | 0.18 | 0.12 | 220 | 770 |
| Cancer fatalities | 504 | 0.92 | $1.9\times10^{3}$ | $2.2\times10^{3}$ | $9.0\times10^{-5}$ | $6.0\times10^{-5}$ | 0.11 | 0.39 |
| Risk (cancer fatalities per year) | $2.5\times10^{-5}$ | $5.5\times10^{-8}$ | $3.7\times10^{-5}$ | $4.5\times10^{-5}$ | $9.0\times10^{-9}$ | $6.0\times10^{-9}$ | $1.1\times10^{-7}$ | $3.9\times10^{-7}$ |

[a] For detailed HWR accident discussion, see appendix section F.2.1.1.
[b] For detailed MHTGR accident discussion, see appendix section F.2.1.2.
[c] For detailed ALWR accident discussion, see appendix section F.2.1.3.
[d] For detailed tritium target extraction facility discussion, see appendix section F.2.1.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.
[e] For detailed tritium recycling facility discussion, see appendix section F.2.3.
[f] The values shown apply to either the Full helium-3 APT or the Phased APT. For detailed APT with helium-3 target system discussion, see appendix section F.2.1.4.2.
[g] Analysis postulated the total failure of the active emergency cooling system and the loss of the heat sink
[h] For detailed APT with spallation-induced lithium conversion target system discussion, see appendix section F.2.1.4.3.
[i] Analysis postulated successful beam trip with the total failure of the active emergency cooling system.
Note: SILC - spallation-induced lithium conversion.
Source: Model results.




[a] The helium-3 target systems for the Full and Phased APT are bounded by the APT with the spallation-induced lithium conversion (SILC) target system shown in this figure.

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**FIGURE 4.4.3.9–1.—*High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Functions for Tritium Supply and Recycling Severe Accidents at Oak Ridge Reservation.***

site boundary. The risk to the population, that takes the probability of the accident into account, is $5.5 \times 10^{-8}$ cancer fatalities per year (table 4.4.3.9–3).

Advanced Light Water Reactor. A range of accident sequences with various release categories was analyzed for the ALWR. One release category for a Large ALWR and one for a Small ALWR were selected to represent the accident consequences for an ALWR (appendix section F.2.1.3). In the event that such an accident were to occur, there would be an estimated 1,900 cancer fatalities for a large ALWR and 2,200 cancer fatalities for a small ALWR in the population within 50 miles and an increased likelihood of cancer fatality of 0.13 for a large ALWR and 0.16 for a small ALWR to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is $3.7 \times 10^{-5}$ for a large ALWR and $4.4 \times 10^{-5}$ for a small ALWR cancer fatalities per year (table 4.4.3.9–3).

Accelerator Production of Tritium with Helium-3 Target System. The large break loss of coolant accident with the total loss of the active emergency cooling system and the heat sink was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $9.0 \times 10^{-5}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $5.5 \times 10^{-9}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $9.0 \times 10^{-9}$ cancer fatalities per year (table 4.4.3.9–3).

Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System. The large break loss of coolant accident with a successful beam trip and the total loss of the active emergency cooling system and was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $6.0 \times 10^{-5}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $4.1 \times 10^{-8}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $6.0 \times 10^{-9}$ cancer fatalities per year (table 4.4.3.9–3).

*Tritium Extraction and Recycling.* The tritium extraction facility is required to support all tritium supply technologies except the APT technology with the helium-3 target system. The tritium recycling facility is required to support all tritium supply technologies. The analyses of postulated high consequence accidents for the tritium extraction and recycling facilities at ORR are presented below.

Tritium Target Extraction Facility. An earthquake and release of process vessel tritium inventory postulated as the high consequence accident. In the event that this accident were to occur, there would be an estimated 0.11 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatalities of $6.5 \times 10^{-6}$ to an individual who may be located at the site boundary. The risk to the population, that takes the probability of an accident into account, is les than $1.1 \times 10^{-7}$ cancer fatalities per year (table 4.4.3.9–3).

Tritium Recycling Facility. An earthquake induced leak/ignition and fire in the unloading station carousel reservoir was postulated as the high consequence accident for the tritium recycling facility. In the event that this accident were to occur, there would be an estimated 0.39 cancer facilities in the population with 50 miles and an increased likelihood of cancer fatality of $2.4 \times 10^{-5}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $3.9 \times 10^{-7}$ cancer fatalities per year (table 4.4.3.9–3).

For comparison purposes with high consequence tritium supply facility accidents, there is a risk of 2,125 cancer fatalities per year from all other natural causes for the same total population of 1,062,000 in the year 2050 within 50 miles of the site.

The analysis of facility accidents for tritium supply at ORR shows that, for high consequence accidents analyzed using the MACCS computer code, the ALWR has the highest consequences and risk and the APT has the lowest consequences and risk. The risk of accidents for any of the tritium supply technologies, tritium extraction, and tritium recycling facilities common to all technologies is low when compared to the human risk of cancer fatalities from all other causes.

The consequences of operational basis or design basis accidents for the tritium extraction and recycling facilities at ORR are shown in table 4.4.3.9–4. The results in table 4.4.3.9–4 should not be compared with the severe accident analysis results in table 4.4.3.9–3 because different computer codes using different calculational approaches were used.

*Less Than Baseline Operations.* Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the HWR unless the baseline HWR core design was downsized. The baseline HWR configuration would adjust to the reduced target through-put requirements by reducing the time that the reactor is required to operate at 100 percent power. It is not anticipated that the overall risk from operating the reactor in this mode would decrease significantly. Accident analyses have not been performed to address accident sequences and initiating events when the reactor is in the cold shut down mode. In addition, operator error has a significant effect on facility risk and if the reactor is shutdown a high percentage of the time, operator error may actually increase when the reactor is at power.

Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the MHTGR or ALWR. The reactor surplus capacity would be used to generate steam for electric power production.

Less than baseline tritium operation would have no change to the MHTGR accident analyses because the analyses assumed that only one of the modules would be involved in the accident.

Less than baseline tritium operation would have no significant change to the APT accident analyses consequences. The accident consequences Full and Phased APT accidents with low to moderate consequences were negligible. For the beyond design basis accident, there was no difference in the Full and Phased accident sequences. Review of the source terms is identical for both accidents. Review of the MACCS computer code out put date for each accident analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results is negligible.

**TABLE 4.4.3.9–4.—*Tritium Supply Technologies and Recycling Low to Moderate Consequence Radioactive Release Accidents and Consequences at Oak Ridge Reservation***

| Parameter | Tritium Supply Technologies and Recycling | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | |
| | | | Large | Small | Full | | |
| | | | | | SILC Target System[f] | | |
| **Accident** | | | | | | | |
| Description | Fuel Assembly failure during charge and discharge operations | Large break in primary system piping | Large break loss of coolant accident | Large break loss of coolant accident | Large break loss of coolant accident[g] | Deflagration[h] | Hydride Bed Rupture |
| Frequency (per year) | 0.01 | 0.01 | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $2.0 \times 10^{-5}$ | $2.0 \times 10^{-4}$ |
| **Consequence** | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | |
| Dose (rem) | 0.14 | 0.18 | 44 | 1.9 | negligible | 0.84 | $3.6 \times 10^{-3}$ |
| Cancer fatalities | $6.8 \times 10^{-5}$ | $9.2 \times 10^{-5}$ | $4.4 \times 10^{-2}$ | $9.7 \times 10^{-4}$ | negligible | $4.2 \times 10^{-4}$ | $1.8 \times 10^{-6}$ |
| Risk (cancer fatalities per year) | $6.8 \times 10^{-7}$ | $9.2 \times 10^{-7}$ | $4.4 \times 10^{-5}$ | $9.7 \times 10^{-7}$ | negligible | $8.4 \times 10^{-9}$ | $3.6 \times 10^{-10}$ |
| ***Population Within 50 Miles*** | | | | | | | |
| Dose (person-rem) | $1.6 \times 10^{3}$ | $2.0 \times 10^{3}$ | $4.9 \times 10^{4}$ | $2.2 \times 10^{5}$ | negligible | $9.9 \times 10^{3}$ | 42 |
| Cancer fatalities | 0.80 | 1.0 | 240 | 11 | negligible | 5.0 | 0.021 |
| Risk (cancer fatalities per year) | $8.0 \times 10^{-3}$ | 0.01 | 0.24 | 0.011 | negligible | $1.0 \times 10^{-4}$ | $4.2 \times 10^{-6}$ |

[a] For detailed HWR accident discussion, see appendix section F.2.2.1.

[b] For detailed MHTGR accident discussion, see appendix section F.2.2.2.

[c] For detailed ALWR accident discussion, see appendix section F.2.2.3.

[d] The APT with helium-3 target system bounding low to moderate consequence accident consequences are bounded by the APT with spallation-induced lithium conversion target system which is nil. For detailed APT discussion, see appendix section F.2.2.4.

[e] For detailed tritium target extraction facility discussion, see appendix section F.2.2.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.

[f] For detailed tritium recycling facility discussion, see appendix section F.2.4.

[g] Analysis postulated all plant protection systems functioned as designed.

[h] Intense rapid burning.

Note: SILC - spallation-induced lithium conversion.

Source: Model results.

*Potential Mitigation Measures.* The accidents postulated for tritium supply technologies and recycling facilities are based on operation and safety analyses that have been performed at similar facilities. One of the major design goals for tritium supply and recycling facilities is to achieve a reduced risk to facility personnel and to public health and safety relative to as low as reasonably achievable.

Worker exposure that may result from the accidental release of radioactive material will be minimized through design features and administrative procedures that will be defined in conjunction with the facility design process. The radiological impacts to workers from accidents could not be estimated for this PEIS because the facility design information needed to support the estimate has not yet been developed. The impacts on workers from accidents will analyzed as part of subsequent project-specific NEPA documentation and in detailed safety analysis documentation that are prepared in conjunction with the facility design process.

The tritium supply and recycling facilities would be designed to comply with current Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide facilities that are highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, and high wind, as well as credible events as appropriate to the site such as fire and explosions, and man-made threats to its continuing structural integrity for containing materials.

The tritium supply and recycling facilities would be designed to resist the effects of severe natural phenomena as well as the effects of man-made threats to its continuing structural integrity. It also would be designed to provide containment of the tritium inventory at all times through the use of multiple, high quality confinement barriers to prevent the accidental release of tritium to the environment. It also would be designed to produce a lower quantity of waste materials as compared to the tritium facilities of the existing weapons complex.

In addition, DOE orders specify the requirements for emergency preparedness at DOE facilities. ORR has comprehensive emergency plans to protect life and property within the facility and the health and welfare of surrounding areas. The emergency plans would be revised to incorporate future DOE requirements and expanded to incorporate the addition of tritium supply and recycling facilities to ORR. Section 4.4.2.9 presents emergency preparedness and emergency plan details at ORR.

#### 4.4.3.10 *Waste Management*

Construction and operation of tritium supply and recycling facilities would impact existing ORR waste management operations, increasing the generation of low-level, mixed low-level, hazardous and nonhazardous wastes, and reintroducing the generation of spent fuel. There would be no high-level or TRU wastes associated with the proposed tritium supply technologies and recycling facilities. All reactor technologies would provide treatment and storage of spent fuel for the life of the facility. Spent nuclear fuel would be managed in accordance with DOE's decisions identified in the ROD after completion of the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. The impacts of a decision to put new tritium supply and recycling facilities at ORR would involve the construction of new treatment facilities for liquid LLW for the HWR, MHGTR and ALWR. There would be no impacts on current facilities for mixed LLW and hazardous waste resulting from any of the tritium supply technologies and recycling facilities. All the technologies would generate enough nonhazardous solid waste to shorten the planned lifetime for the sanitary/industrial landfills or require a proportional expansion. All of the new technologies would require the construction of treatment facilities for sanitary liquid waste. This section provides a description of the waste generation, treatment, storage, and disposal requirements of the tritium supply technologies and recycling facilities and the potential impacts on waste management at ORR.

**No Action.** Under No Action, spent nuclear fuel, TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes would continue to be managed at ORR from the missions outlined in section 3.3.3. Table 4.4.3.10–1 lists the projected waste generation rates and treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1992 environmental data with appropriate adjustments made for those changing operational

requirements where the volume of wastes generated are identifiable. The projection does not include wastes from future, yet uncharacterized, environmental restoration activities.

A small quantity of spent nuclear fuel could be generated by the Oak Ridge National Laboratory High-Flux Isotope Reactor in the production of isotopes for commercial applications and in conducting research. As indicated in table 4.4.2.10–2 only 40 percent of the reactor pool is currently full and it should be capable of storing the generated fuel rods for many years. Other fuel and irradiated nuclear material is stored in various locations at ORR awaiting final disposition.

Small quantities of TRU waste would be generated for isotope production and research activities at the Oak Ridge National Laboratory. Most of this type of waste would be generated in remedial action projects. TRU waste previously buried and stored would be repackaged into TRUPACT-II containers to meet the WIPP waste acceptance criteria for eventual shipment to WIPP once it can demonstrate compliance with the environmental standards for the management and disposal of TRU wastes (40 CFR 191) and the land disposal standards of RCRA as amended (40 CFR 268), or to another TRU waste disposal facility should WIPP prove unsatisfactory. If shipments to WIPP are delayed, plans for additional TRU storage facilities would be required or the waste could be shipped to another TRU waste disposal facility.

Liquid LLW would be solidified, neutralized, and allowed to evaporate. Some liquid waste would also be incinerated. Solid LLW would be compacted and stored onsite at K-25 and the Oak Ridge National Laboratory as indicated in section 4.4.2.10. Contaminated scrap metal would be processed for beneficial reuse where possible, including the DOE Shielding Block Program, or be size-reduced for disposal. Hazardous waste would be treated in the same way as LLW, but sent offsite for disposal.

Mixed solid waste would be treated and disposed of according to the ORR Site Treatment Plan, which is being developed pursuant to the *Federal Facility Compliance Act*. Mixed liquid wastes would also be incinerated at the TSCA incinerator. The resulting waste would then be stored in a RCRA-permitted facility in DOT-approved containers until it is shipped to an offsite disposal facility. Some of the waste would be placed in interim storage until new technologies for treatment and disposal are identified and evaluated.

A new industrial pretreatment facility for liquid discharges from Y-12 to the city of Oak Ridge sanitary system would be constructed under the terms of its Industrial Pretreatment Permit. Nonhazardous sanitary and nonradioactive process waste liquids would be treated in conventional sewage treatment plants. The resultant solids would be disposed of with solid nonhazardous waste in a permitted landfill sized to handle projected future waste volumes.

**Tritium Supply and Recycling.** Tritium supply and recycling facilities that will support the nuclear weapons stockpile requirements would treat and package all waste generated in support of this activity into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2. The resultant waste effluents are shown in section 3.4. Waste generated during construction would consist of wastewater, nonhazardous solids, and hazardous waste. The nonhazardous wastes would be sent offsite to the city of Oak Ridge landfill. The hazardous wastes would be shipped to a commercial RCRA-permitted treatment and disposal facility. Operation of the three reactor-based tritium supply technologies and recycling facilities would generate spent fuel, and all four technologies would generate low-level, mixed low-level, hazardous, and nonhazardous wastes. The volume of the waste streams from tritium supply would vary according to the technology chosen. Table 4.4.3.10–2 lists the total estimated waste volumes projected to be generated at ORR as a result of various tritium supply technologies and recycling facilities. The data for the three major activities (K-25, Y-12, and Oak Ridge National Laboratory) at ORR were combined (ORR 1993a:8). The incremental waste volumes from the tritium supply technologies and recycling facilities that were added to the No Action projection can be found in appendix section A.2. Table 4.4.3.10–3 lists potential waste management impacts at ORR at the time of initial operation of the tritium facilities. Spent nuclear fuel storage for the life of the reactors is provided for in the reactor designs (appendix section

**TABLE 4.4.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management Under No Action at Oak Ridge Reservation*[a] [Page 1 of 2]**

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | None | NA | Pools and storage vaults | 0.08 | None | NA |
| **Transuranic (Solid)** | | | | | | | |
| Contact-handled | 14 | None | NA | Staged for shipment | 800 | None, Federal repository in future | NA |
| Remote-handled | 5 | None | NA | Staged for shipment | 290 | None, Federal repository in future | NA |
| **Low-Level** | | | | | | | |
| Liquid | 2,900 [b] (587,000 gal) | Neutralization & precipitaion | 479,000 (97,000,000 GPY) | Stored onsite | 1,500 (302,000 gal) | None | NA |
| Solid | 9,300[c] | Compaction, smelting, incineration | Offsite | Stored onsite | 202,000 | Onsite | Planned |
| **Mixed** | | | | | | | |
| Liquid | 2,330 [d] (470,000 gal) | Settlement, incineration, ion exchange | 802,000 (162,000,000 GPY) | Long-term storage onsite | 128,000 (26,000,000 gal) | NA | NA |
| Solid | 11,060 | None | Planned | Staged for shipment | 159,000 | None - offsite to NTS pending | NA |
| **Hazardous** | | | | | | | |
| Liquid | 94,000 [e] (19,000,000 gal) | Neutralization, settlement | 107,000 (21,000,000 GPY) | Tanks | 1,440 (290,000 gal) | Offsite | NA |
| Solid | 1,150 | Compaction/ incineration | 2,100 | Staged for shipment | 163,000 | Offsite | NA |

TABLE 4.4.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management Under No Action at Oak Ridge Reservation*[a] [Page 2 of 2]

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 2,400,000 (484,000,000 gal) | Offsite, Neutralization, Biological Degradation | 3,500,000 (700,000,000 GPY) | None | NA | Offsite/NPDES outfall | NA |
| Solid | 77,000 | None | NA | None | NA | Landfill (onsite) Landfill (offsite) | 640,000 |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | 988,000 [f] (199,000,000 gal) | Evaporation, incineration, neutralization | 2,300,000 (464,000,000 GPY) | None | NA | Offsite, NPDES outfall | NA |
| Solid | 9,040 [g] | None | NA | None; stockpiled | NA | Landfill (onsite) | 1,700,000 |

[a] The generation rate, treatment, and storage data for the three sites at ORR were combined.

[b] Some liquid LLW included in liquid hazardous waste because K-25 does not separate these two wastes.

[c] Includes scrap metal and sludge from the Sanitary Wastewater Treatment Plant; may include some PCB-tainted waste.

[d] Some liquid mixed waste included in liquid hazardous waste because K-25 does not separate these two wastes.

[e] Includes 9,200 $yd^3$ of hydrogen softener blowdown from the steam plant, 50,000 $yd^3$ of TSCA Incinerator waste water.

[f] Includes wastewater treated at the Steam Plant Wastewater Treatment Facility and Plating Rinsewater Treatment Facility; includes 374,000 $yd^3$ from Process Waste Treatment Facility and steamplant blowdown.

[g] Includes construction/demolition spoil and scrap metal.

NA - not applicable.

Source: ORR 1993a:8.

**TABLE 4.4.3.10–2.**—*Estimated Generated Annual Spent Nuclear Fuel and Waste Volumes for Tritium Supply Technologies and Recycling at Oak Ridge Reservation*[a]

| Category | No Action ($yd^3$) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR ($yd^3$) | MHTGR ($yd^3$) | ALWR/Large ($yd^3$) | ALWR/Small ($yd^3$) | APT ($yd^3$)[b] |
| **Spent Nuclear Fuel** | None | 7 | 80 | 30 | 15 | None |
| **Low-level** | | | | | | |
| Liquid | 2,910 (587,000 gal) | 13,300 (2,690,000 gal) | 5,510 (1,110,000 gal) | 27,700 (5,590,000 gal) | 6,820 (1,380,000 gal) | 2,910 (587,000 gal) |
| Solid | 9,300 | 14,900 | 11,000 | 10,400 | 10,300 | 10,200 |
| **Mixed Low-Level** | | | | | | |
| Liquid | 2,330 (470,000 gal) | 2,330 (470,000 gal) | 2,330 (470,000 gal) | 2,330 (470,000 gal) | 2,330 (470,000 gal) | 2,330 (470,000 gal) |
| Solid | 11,100 | 11,200 | 11,100 | 11,100 | 11,100 | 11,100 |
| **Hazardous** | | | | | | |
| Liquid | 94,100 (19,000,000 gal) | 94,100 (19,000,000 gal) | 94,100 (19,000,000 gal) | 94,100 (19,000,000 gal) | 94,100 (19,000,000 gal) | 94,100 (19,000,000 gal) |
| Solid | 1,150 | 1,190 | 1,250 | 1,190 | 1,190 | 1,150 |
| **Nonhazardous (Sanitary)** | | | | | | |
| Liquid | 2,400,000 (484,000,000 gal) | 14,100,000 (2,860,000,000 gal) | 10,600,000 (2,140,000,000 gal) | 33,700,000 (6,800,000,000 gal) | 16,600,000 (3,360,000,000 gal) | 4,500,000 (900,000,000 gal) |
| Solid | 77,000 | 92,000 | 91,800 | 91,300 | 88,600 | 85,600 |
| **Nonhazardous (Other)** | | | | | | |
| Liquid | 985,000 (199,000,000 gal) | 985,000 (199,000,000 gal) | 985,000 (199,000,000 gal) | 985,000 (199,000,000 gal) | 985,000 (199,000,000 gal) | 985,000 (199,000,000 gal) |
| Solid | 9,040 | 21,900[c] | 21,800[d] | 21,200[e] | 18,900[f] | 15,400[g] |

[a] The No Action waste volumes are from table 4.4.3.10–1. The incremental waste volumes from the tritium alternatives that were added to the No Action projections can be found in appendix section A.2 (tables A.2.1.1–4, A.2.1.2–4, A.2.1.3–4, A.2.1.3–5, A.2.1.4–4, and A.2.2.1–4). The generation rate, treatment, and storage data for the three sites at ORR were combined (ORR 1993a:8). Waste volumes have been rounded to three significant figures.

[b] The APT and recycling waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target waste volumes are approximately the same with the exception of solid LLW which is 9,722 $yd^3$.

[c] Includes 12,900 $yd^3$ of recyclable waste.

[d] Includes 12,800 $yd^3$ of recyclable waste.

[e] Includes 12,200 $yd^3$ of recyclable waste.

[f] Includes 9,900 $yd^3$ of recyclable waste.

[g] Includes 6,400 $yd^3$ of recyclable waste.

A.2.1). The interim management of spent nuclear fuel (pending the availability of a geologic repository) would be in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. Because spent nuclear fuel reprocessing is not planned, no HLW would be generated. Without plutonium production, no TRU waste would be generated. The treatment, storage, and disposal of mixed LLW and hazardous waste from all the technologies could be handled by current facilities.

*Heavy Water Reactor.* Spent nuclear fuel would be generated at the rate of 7 $yd^3$ per year. The HWR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The HWR would produce quantities of liquid LLW which would increase by a factor of five the quantity of wastes as compared to No Action. Construction of a liquid radioactive waste facility would be required. The amount of solid LLW generated by the HWR would increase 60 percent over the rate generated under No Action. Additional treatment and staging facilities may be required. Assuming a 15,300 $ft^3$ per acre LLW disposal usage factor, this would require approximately 3.5 acres per year for LLW disposal. Expansion of the planned LLW disposal facility would be necessary. With the addition of an HWR facility, the total amount of mixed and hazardous wastes would not change significantly compared to No Action. Thus no additional impacts from these wastes are anticipated if this technology were chosen for this site. The HWR would generate much larger quantities of nonhazardous liquid and solid wastes than currently projected for ORR under No Action. The amount of sanitary liquid waste would be greater by a factor of almost 7. The generation of solid sanitary waste would increase 19 percent. Therefore, additional treatment capacity and landfill capacity would be necessary. Additional treatment facilities or expansion of existing or planned facilities would be analyzed in a site-specific NEPA analysis.

Siting an HWR without tritium recycling facilities at ORR would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above and table 4.4.3.10–3. Liquid mixed LLW would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, and liquid nonhazardous wastes would not change from those described above and in table 4.4.3.10–3. The generation of solid LLW would increase by 56 percent over No Action, and would require approximately 3.3 acres per year of LLW disposal. The increase in generation rate over No Action for solid sanitary wastes would decrease from 19 percent to 10 percent; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Modular High Temperature Gas-Cooled Reactor.* Spent nuclear fuel would be generated at the rate of 80 $yd^3$ per year. The MHTGR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The MHTGR would produce quantities of liquid LLW which would increase by 90 percent the amount being generated under No Action. Construction of a liquid radioactive waste facility would be required. The MHTGR would increase by 18 percent the amount of solid LLW being generated under No Action. Expansion of existing or additional staging facilities may be needed. Expansion of the planned LLW disposal facility may be necessary to meet the 1 acre per year of LLW disposal. Approximately the same amount of mixed and hazardous wastes as in No Action would be generated by the MHTGR. Thus no additional impacts from these wastes are anticipated if this technology were chosen for this site. The MHTGR would generate greater quantities of nonhazardous liquid and solid wastes than normal operations at ORR. This would cause increased need for treatment and landfill capacity.

Siting an MHTGR without tritium recycling facilities at ORR would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above and table 4.4.3.10–3. Liquid mixed LLW would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, and liquid nonhazardous wastes would not change from those described above and in table 4.4.3.10–3. The generation of solid LLW would increase by 14 percent over No Action, and would require approximately 0.8 acres per year of LLW disposal. The increase in generation rate over No Action for solid sanitary wastes would decrease

**TABLE 4.4.3.10–3.**—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Oak Ridge Reservation* [Page 1 of 2]

| | Tritium Supply Technologies and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Spent Nuclear Fuel** | New[b] | New storage facility | New[b] | New storage facility | New[b] | New storage facility | New[b] | New storage facility | None | None |
| **Low-Level** | | | | | | | | | | |
| Liquid | +358 | New treatment facility | +89 | New treatment facility | +852 | New treatment facility | +135 | New treatment facility | None | None |
| Solid | +60 | 3.5 acres per year of LLW disposal | +18 | 1 acre per year of LLW disposal | +11 | 1.2 acres per year of LLW disposal | +11 | 0.7 acres per year of LLW disposal | +10 | 0.6 acres per year of LLW disposal |
| **Mixed Low-Level** | | | | | | | | | | |
| Liquid | <+1 | None | <+1 | None | <+1 | None | <+1 | None | <+1 | None |
| Solid | +1 | None | <+1 | None | <+1 | None | <+1 | None | <+1 | None |
| **Hazardous** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +4 | None | +9 | None | +3 | None | +3 | None | <+1 | None |
| **Nonhazardous (Sanitary)** | | | | | | | | | | |
| Liquid | +490 | New treatment facilities | +342 | New treatment facilities | +1,310 | New treatment facilities | 594 | New treatment facilities | +88 | New treatment facilities |
| Solid | +19 | Landfill life reduced or expansion required | +19 | Landfill life reduced or expansion required | +19 | Landfill life reduced or expansion required | 15 | Landfill life reduced or expansion required | +11 | Landfill life reduced or expansion required |

TABLE 4.4.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Oak Ridge Reservation* [Page 2 of 2]

| | Tritium Supply Technologies and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Nonhazardous (Other)** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +143 | None - Project wastes are recyclable | +142 | None - Project wastes are recyclable | +135 | None - Project wastes are recyclable | +110 | None - Project wastes are recyclable | +71 | None - Project wastes are recyclable |

[a] This column reflects percentage change in generation rate over No Action. Percentage change was calculated using waste volumes prior to rounding. Do not use rounded numbers in table 4.4.3.10–2 to calculate percentage change.

[b] ORR generated small quantities in 1992 but was projected to generate none in 2010; thus, in 2010 spent fuel generation was considered to be new.

Source: Tables 4.4.3.10–1 and 4.4.3.10–2.

from 19 percent to 10 percent; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Advanced Light Water Reactor (Large).* Spent nuclear fuel would be generated at the rate of 30 $yd^3$ per year. The ALWR would be designed to provide the necessary treatment and storage facilities for spent nuclear fuel. The Large ALWR would increase the generation of liquid LLW by a factor of 9. Construction of a liquid radioactive waste facility would be required. The 11 percent increase in the generation of solid LLW would require 1.2 acres per year of LLW disposal. Expansion of existing, or additional, staging facilities and planned LLW disposal facility may be required. Approximately the same amount of mixed and hazardous wastes as in No Action would be generated if the Large ALWR facility is added to ORR. No additional impacts from these wastes are anticipated. The Large ALWR does generate greater quantities of nonhazardous liquid and solid wastes than normal operations at ORR. This would cause increased need for treatment and landfill capacity.

Siting a Large ALWR without tritium recycling facilities at ORR would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above and table 4.4.3.10–3. Liquid mixed LLW would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, and liquid nonhazardous wastes would not change from those described above and in table 4.4.3.10–3. The generation of solid LLW would increase by 8 percent over No Action, and would require approximately 1 acre per year of LLW disposal. The increase in generation rate over No Action for solid sanitary wastes would decrease from 19 percent to 9 percent; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Advanced Light Water Reactor (Small).* Spent nuclear fuel would be generated at the rate of 15 $yd^3$ per year. The Small ALWR facility would be designed to have the necessary treatment and storage facilities for spent fuel. The Small ALWR facility would produce approximately the same quantity of wastes as the Large ALWR except for liquid LLW and nonhazardous wastes. The amount of liquid LLW generated from the Small ALWR is approximately 25 percent of the Large ALWR generated wastes while the amount of solid LLW is approximately the same. A solid LLW disposal rate of 0.7 acres per year would be required. The amount of nonhazardous liquid waste generated by the Small ALWR is about half the amount generated by the Large ALWR while the amount of solid waste is about the same. In general, as seen in table 4.5.3.10–3 the impacts on treatment and staging facilities are the same.

Siting a Small ALWR without tritium recycling facilities at ORR would not affect the generation of nor change the impacts from spent nuclear fuel or liquid LLW as described above and table 4.4.3.10–3. Liquid mixed LLW would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, and liquid nonhazardous wastes would not change from those described above and in table 4.4.3.10–3. The generation of solid LLW would increase by 7 percent over No Action, and would require approximately 0.5 acres per year of LLW disposal. The increase in generation rate over No Action for solid sanitary wastes would decrease from 15 percent to 5 percent; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Accelerator Production of Tritium.* The APT does not generate spent nuclear fuel. Any liquid LLW can be solidified at the point of generation. Mixed low-level and hazardous wastes generation increase is less than 1 percent; thus, no impacts are expected. The APT would increase the generation of nonhazardous sanitary solid waste by 11 percent over No Action. Thus, there would be no additional impact for this facility except for an increased need for LLW at the rate of 0.6 acres per year and landfill capacity.

Siting an APT without tritium recycling facilities at ORR would not affect the generation of nor change the impacts from liquid LLW as described above and table 4.4.3.10–3. Liquid mixed LLW would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, and liquid nonhazardous wastes would not change from those described above and in table 4.4.3.10–3. The generation of solid LLW would increase by 6 percent over No Action, and would require

approximately 0.4 acres per year of LLW disposal. A less than 2 percent increase in the generation of solid sanitary nonhazardous wastes over No Action would have minimal impact on the planned lifetime of the landfill.

*Less Than Baseline Operations.* In the event of a reduced baseline tritium requirement the waste volumes shown in table 4.4.3.10–2 would not appreciably change as a result of the HWR operating at less power, and the MHTGR and ALWR irradiating fewer target rods. In the case of a Phased APT using the helium-3 target, the waste volumes are approximately the same as the Full APT using the helium-3 target.

**Potential Mitigation Measures.** Each new tritium supply technology and recycling facility would be designed to process its own waste into a form suitable for storage or disposal and would use proven waste minimization and pollution prevention technologies whenever possible. Some facility designs produce waste quantities or waste forms that could undergo additional reductions by utilizing the emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be major factors in determining the final design of any facility constructed as part of the proposed action at ORR. Pollution prevention and waste minimization would also be analyzed as part of the site-specific analyses and tiered NEPA documents.

Some of the facilities, such as the Above Grade Storage Facility at Y-12, planned for or under construction at ORR to handle wastes generated from past and current operations and from environmental restoration activities may be able to treat, store, or dispose of tritium-related wastes. The use of existing incineration capability at ORR could reduce the volume of solid LLW to be disposed of by a factor of 20. Utilization of existing facilities, or the need for the construction of new facilities, would be addressed in site-specific NEPA documents.

## 4.5 PANTEX PLANT

Pantex was established in 1951, and currently occupies approximately 16,000 acres near Amarillo, TX. The current defense program mission at Pantex is to assemble and disassemble nuclear weapons, perform weapons repair, modification and disposal, conduct stockpile evaluation and testing, and provide interim storage for plutonium. Section 3.3.5 provides a description of all the DOE mission and support facilities at Pantex. The location of Pantex is illustrated in figure 4.5–1.

### 4.5.1 Description of Alternatives

Under the proposed action, any one of the four tritium supply technologies (HWR, MHTGR, ALWR, or APT) alone or collocated with a new tritium recycling facility could be sited at Pantex. Section 3.4.2 provides a description of the tritium supply technologies and section 3.4.3.1 describes the tritium recycling facility. Figure 4.5.1–1 shows the location of existing facilities within Pantex and areas for the proposed TSS.

Under No Action, Pantex would continue to operate its current and planned missions, developing and fabricating HE components, assembling and disassembling weapons as required to support the projected stockpile requirements, and other missions as described in section 3.3.5. No facilities at Pantex would be phased out as a result of the proposed action alternatives discussed in this PEIS.

### 4.5.2 Affected Environment

The following sections describe the affected environment at Pantex for land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure at Pantex, the radiation and hazardous chemical environment, and the waste management conditions are described.

#### 4.5.2.1 *Land Resources*

The discussion of land resources at Pantex includes land use and visual resources.

**Land Use.** The Pantex site is located within Carson County in the Panhandle region of Texas, 17 miles east-northeast of downtown Amarillo. The Pantex site covers 15,000 acres of land of which approximately 9,000 acres are owned by the Federal government and 5,855 acres are leased from Texas Tech. All owned and leased buildings on the site are administered, managed, and controlled by DOE. DOE owns an additional remote tract of 1,080 acres of undeveloped land at Pantex Lake. This property is held by DOE to retain the water rights. Generalized land uses at Pantex and the vicinity are shown on figure 4.5.2.1–1. Future land uses proposed in the Pantex Site Development Plan are shown on figure 4.5.2.1–2. Future land uses concentrate on centralization of facilities by relocations away from site boundaries into an interior core.

Plant operations are currently located on approximately 1,800 acres of developed land. Three additional parcels, totaling 2,240 acres, are designated for future industrial sites as shown in figure 4.5.2.1–3. Any of these three future industrial sites could support the potential tritium supply and recycling facilities.

The Texas Tech Agriculture Research operations use DOE-leased land not actively used for Pantex operations for agricultural use. Agricultural activities generally consist of dry farming and livestock grazing. A limited amount of crop irrigation occurs. Except for the playas, the Soil Conservation Service considers these lands prime farmland when irrigated. Texas Tech land also contains four dwelling units located approximately 3 miles southwest of the weapons assembly and disassembly, and high explosives production core.

The land surrounding Pantex is rural private property. The closest offsite residences are approximately 100 feet west of the plant boundary along Farm-to-Market Road 683. Most of the surrounding land is prime farmland when irrigated, with the exception of the area northwest of the plant site, which is rangeland. Some property owners have enrolled their land in the Federal Conservation Reserve Program. Under terms of the program, the land is placed in a dormant state for 10 years and cannot be cultivated or grazed. The majority of the land, however, is cultivated. The land is generally dry farmed; however, some fields are irrigated from local playas or from the Ogallala

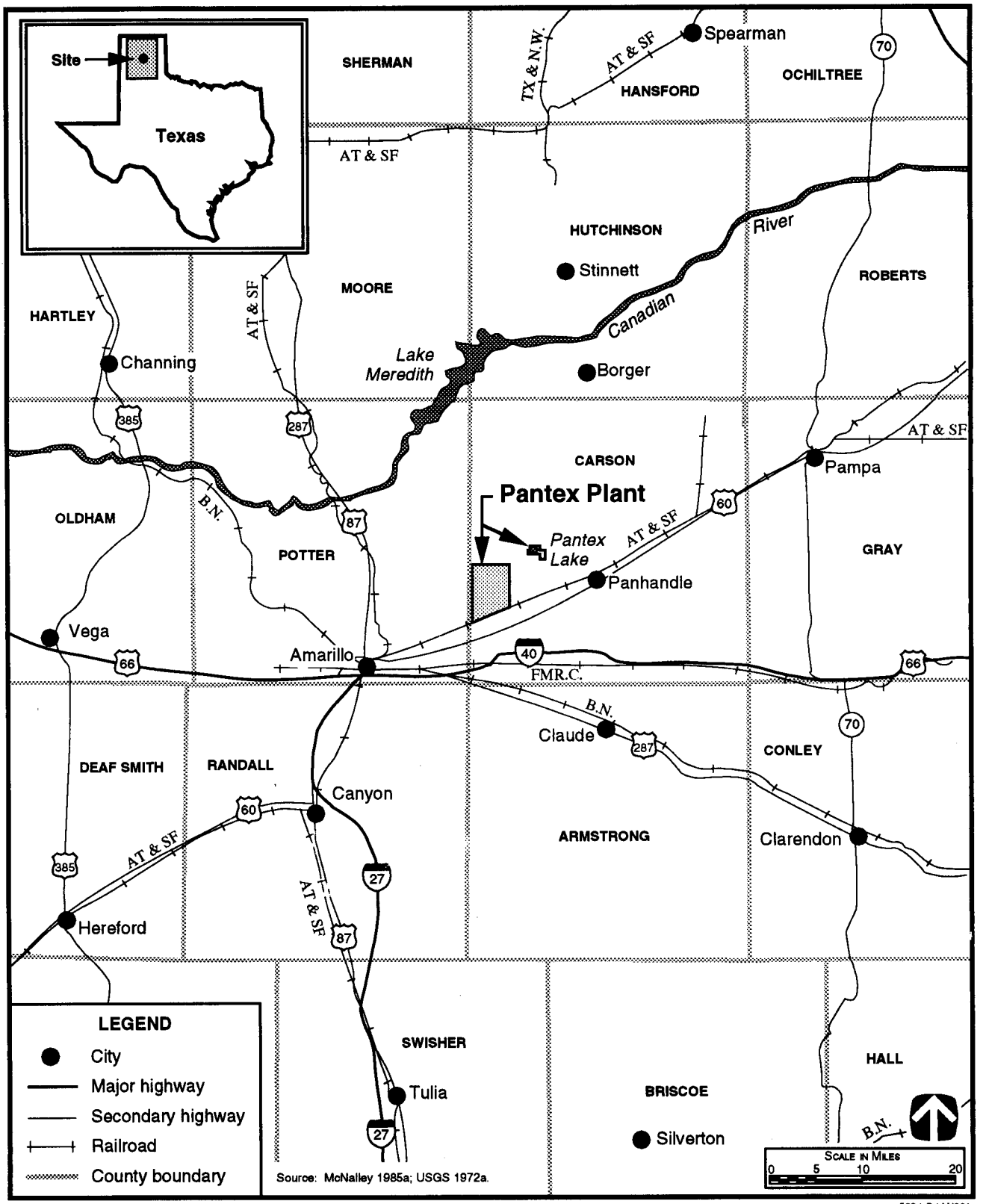



**FIGURE 4.5–1.—*Pantex Plant, Texas, and Region.***

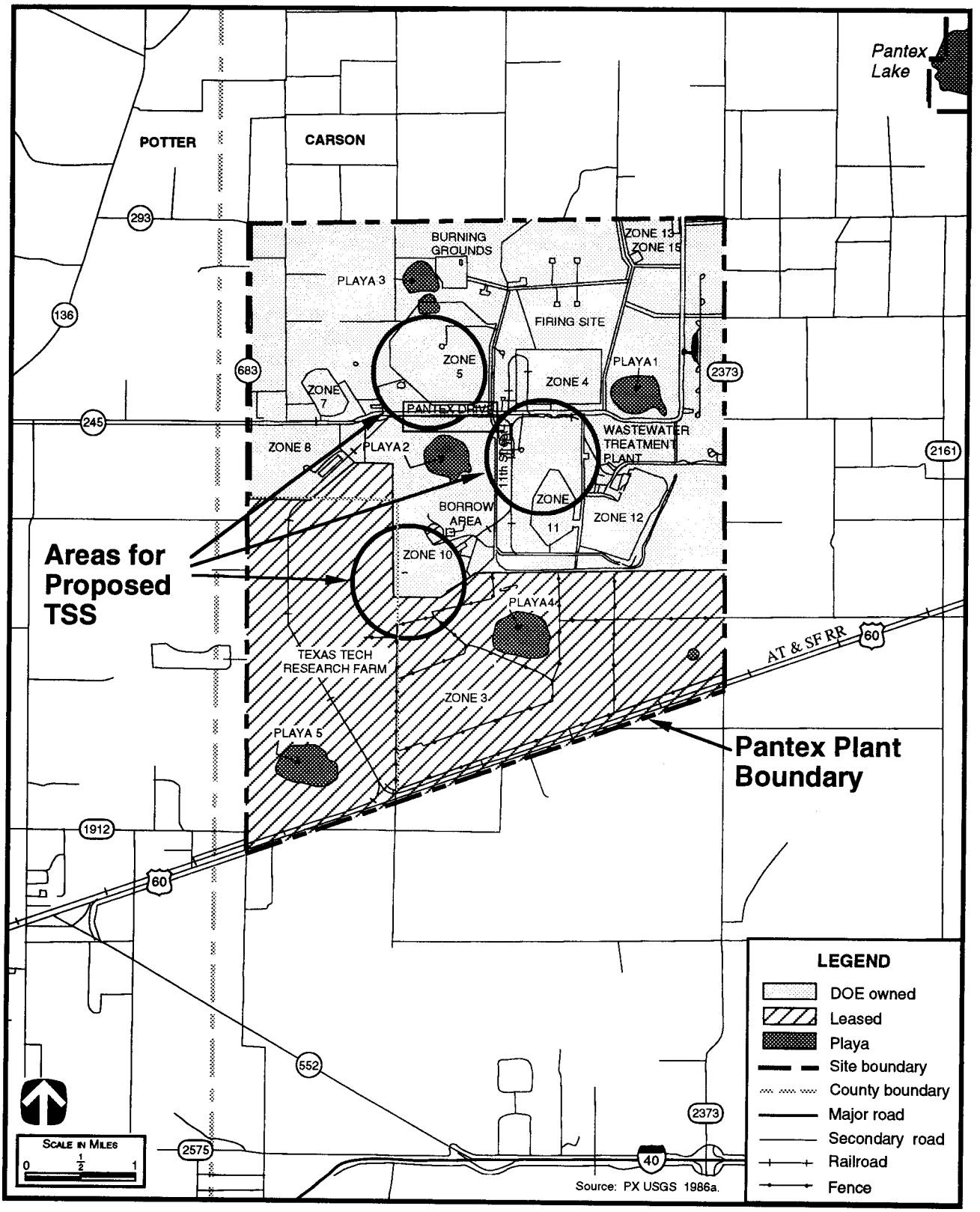
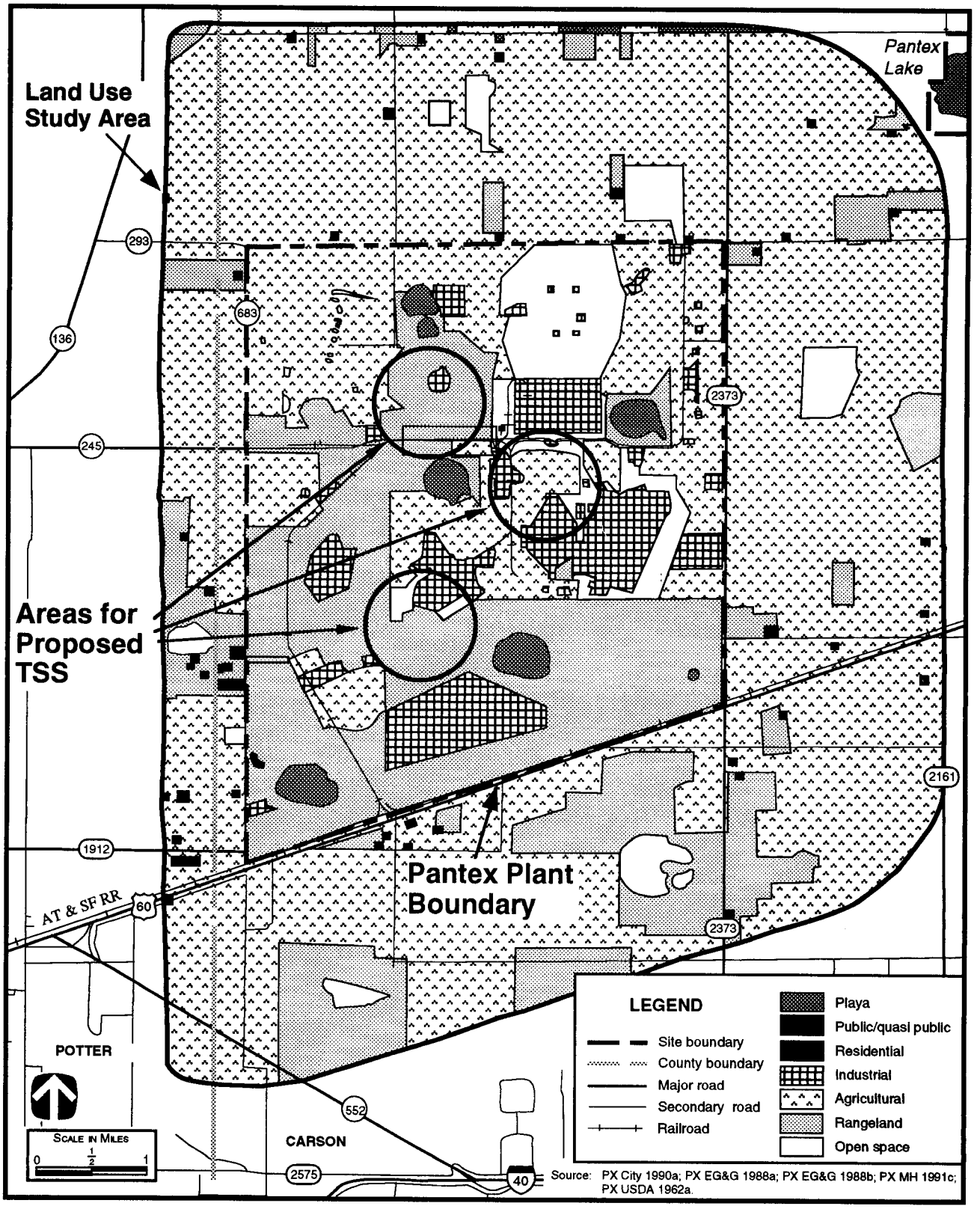



**FIGURE 4.5.1–1.**—*Primary Facilities, Proposed Tritium Supply Sites, and Testing Areas at Pantex Plant.*




5122-PAN/006

**FIGURE 4.5.2.1–1.**—***Generalized Land Use at Pantex Plant and Vicinity.***

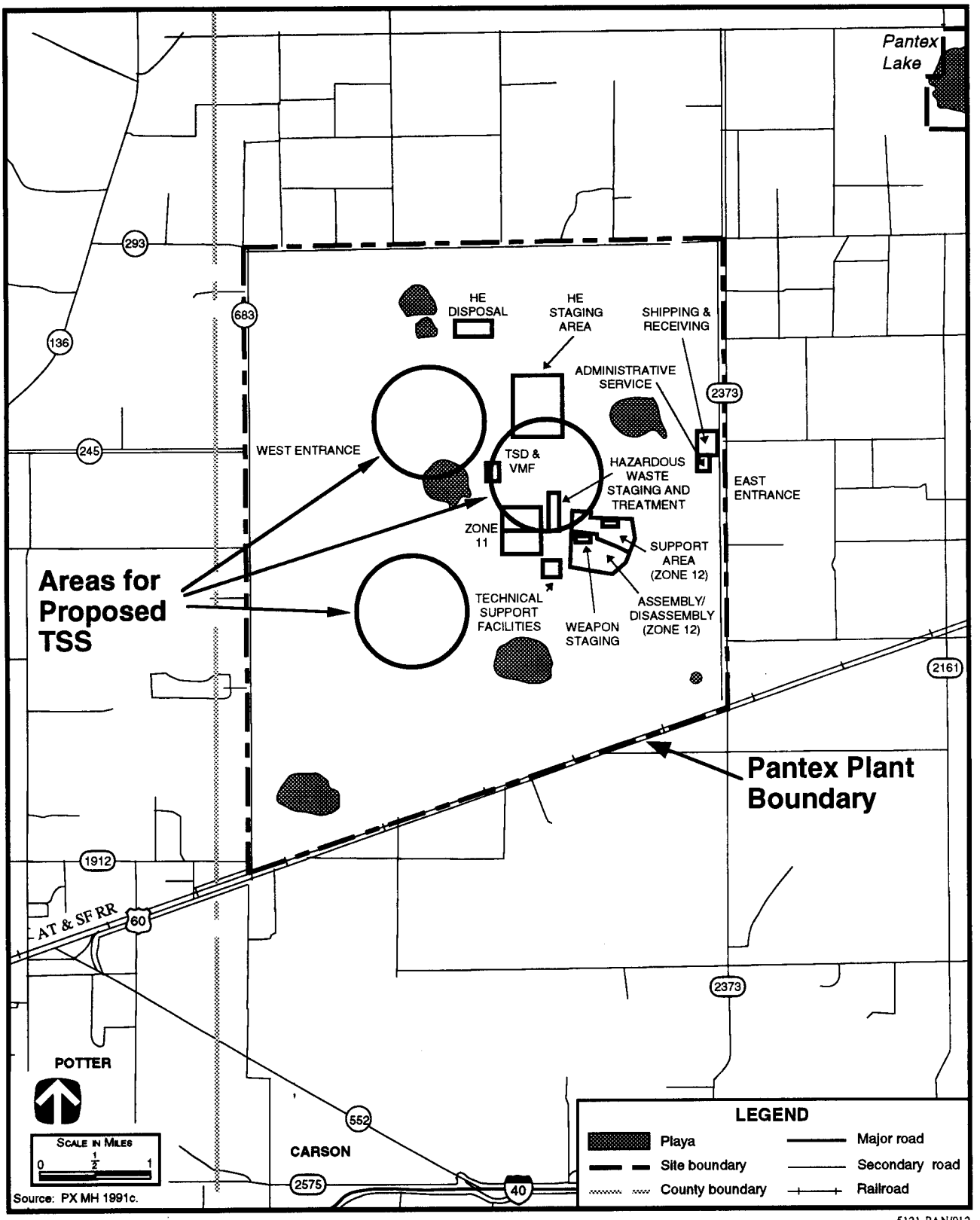



**FIGURE 4.5.2.1–2.—*Future Land Use at Pantex Plant.***

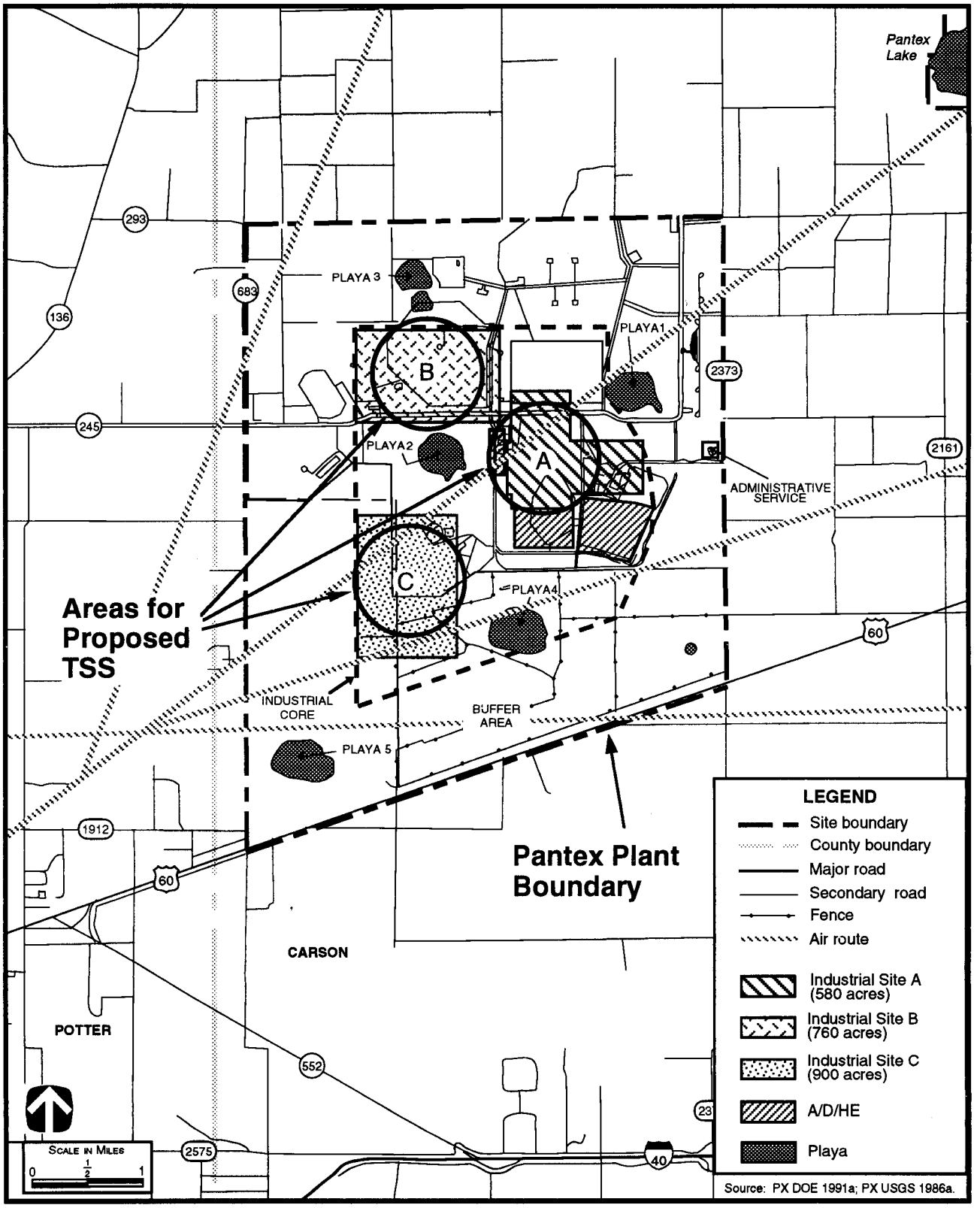



**FIGURE 4.5.2.1–3.**—***Designated Industrial Sites at Pantex Plant.***

5153-PAN/013

aquifer. The packing plant of Iowa Beef Packers, Inc., is the only industrial activity within 2 miles of the plant.

Pantex is crossed by four low-altitude Federal airways used by the Amarillo International Airport for aircraft landings and takeoffs. The runway is located approximately 7 miles southwest of the site boundary. The Height Hazard and Land Use Ordinance for Amarillo International Airport overlays approximately 75 percent of Pantex, with building height limits ranging from 750 to 1,425 feet above the ground surface (PX BDC 1989a).

The Amarillo Comprehensive Plan has designated land for future growth. The direction for future residential development is anticipated to occur toward the southwest, away from the plant. The East Planning Area of the city, which extends to within 2 miles of the plant site, has historically been one of the slower growing residential areas. Because of the presence of the airport and important industrial use in this area, the comprehensive plan encourages compatible use rather than residential use. The largest residential area in this planning area is the site of the base housing of former Amarillo Air Force Base. The base housing, which has been converted to rental housing, is located approximately 3 miles southwest of the plant boundary.

**Visual Resources.** Pantex is sited within a landscape typical of the High Plains region of Texas consisting of cultivated cropland and rangeland. The Pantex site consists of operational facilities of the plant and the inactive facilities of the former World War II ammunition plant. These industrial land uses are surrounded by cropland and rangeland that blend into the offsite viewscape. This mixed use of industrial and agricultural uses is consistent with the Bureau of Land Management's Class 4 VRM designation.

The most sensitive viewpoint of the plant site is located 1.5 miles southeast of the plant at the intersection of U.S. Route 60 and Farm-to-Market Road 2373. U.S. Route 60 is part of the Texas Plains Trail, a scenic road with Pantex a designated point of interest. Much of the view of the plant along this highway is obscured by the elevated railroad right-of-way. The plant is still visible, appearing as low clusters of buildings on a flat horizon. The cylindrical water towers are the most visible feature because of their height. The operations areas are well defined at night by the intense security lighting. The plant operations areas are also visible from Interstate 40, with the closest viewpoint being the rest area approximately 6 miles away. This viewpoint is similar to that described for U.S. Route 60; however, because of the greater distance, the plant facilities are not as prominent.

Public access to Pantex and its buffer areas is strictly controlled and limited to authorized personnel, visitors, and the agricultural lessee. Public access adjacent to the plant perimeter is limited to three Farm-to-Market Roads and U.S. Route 60. The plant facilities are generally visible from the low-density rural housing that surrounds the site.

### 4.5.2.2 *Site Infrastructure*

Section 3.3.5 describes the current missions at Pantex. To support these missions, an extensive infrastructure exists as shown in table 4.5.2.2–1. Of critical importance to the proposed action is the electrical power infrastructure at each potential site. The regional electrical power pool areas from which Pantex draws its power are the Electric Reliability Council of Texas and West Central Power Pool. Characteristics of these combined power pools are given in table 4.5.2.2–2.

**TABLE 4.5.2.2–1.—*Baseline Characteristics for Pantex Plant***

| Current Characteristics | Value |
|---|---|
| **Land** | |
| Area (acres) | 16,000 |
| Roads (miles) | 47 |
| Railroads (miles) | 17 |
| **Electrical** | |
| Energy consumption (MWh/yr) | 77,000 |
| Peak load (MWe) | 13 |
| **Fuel** | |
| Natural gas ($ft^3$/yr) | 520,000,000 |
| Oil (GPY) | 274,000 |
| Coal (ton/yr) | 0 |
| **Steam** (lb/hr) | 75,000 |

Source: PX 1993a:2

**TABLE 4.5.2.2–2.—*Regional Power Pool Electrical Summary for Pantex Plant***

| Type Fuel | Production (percent) |
|---|---|
| Coal | 45 |
| Nuclear | 9 |
| Hydro/geothermal | 2 |
| Oil/gas | 37 |
| Other[a] | 7 |
| **Total Annual Production:** 385,096,000 MWh | |
| **Total Annual Load:** 382,174,000 MWh | |
| **Energy Exported Annually[b]:** 2,862,000 MWh | |
| **Generating Capacity:** 86,678 MWe | |
| **Peak Demand:** 74,910 MWe | |
| **Capacity Margin[c]:** 13,231 MWh | |

[a] Includes power from both utility and nonutility sources.
[b] Energy exported is not the difference of production and load due to system losses and pumped storage.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

### 4.5.2.3 *Air Quality and Acoustics*

The following describes existing air quality and acoustics including a review of the meteorology and climatology in the vicinity of Pantex. More detailed discussions of the air quality and acoustics methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.1.3.5.

**Meteorology and Climatology.** The climate at Pantex and in the surrounding region is characteristically that of a continental steppe (Trewartha 1954a). It is typified by large variations in temperature and precipitation from year to year, with summers that are hot and dry and winters that are mild. The annual average temperature in the Amarillo region is 57.2 °F; average daily temperatures vary from a minimum of 21.7 °F in January to a maximum of 91.4 °F in July. The average annual precipitation is approximately 19 inches (NOAA 1991c). Prevailing wind directions at Pantex are from the south to southwest. The annual average wind speed is 13.6 mph. Additional information related to meteorology and climatology at Pantex is presented in appendix section B.1.3.5.

**Ambient Air Quality.** Pantex is located within the Amarillo-Lubbock Intrastate AQCR 211, which is currently designated as "attainment" or "unclassified" by EPA (40 CFR 81.344) with respect to the NAAQS for criteria pollutants (40 CFR 50). Appendix table B.1.3.1–1 lists the NAAQS for these criteria pollutants. These standards have been adopted by the State of Texas (PX ACB 1993a). There are no Prevention of Significant Deterioration (40 CFR 52.21) Class I areas in the vicinity of Pantex.

Pantex does not operate any ambient air quality monitoring stations that measure criteria pollutant emissions. Ambient air quality monitoring data are supplied by the State of Texas from stations located in Amarillo. Appendix table B.1.3.5–1, presents ambient air quality monitoring data from 1986 to 1991 for $PM_{10}$ and Pb. The data indicate that these regulated pollutants were in compliance with applicable ambient standards.

Historically, the primary emission sources of criteria pollutants at Pantex are the steam plant boilers, the explosives burning operation, and emissions from vehicles (appendix table B.1.3.5–2) (PX DOE 1983a). Potential emission sources of hazardous/toxic air pollutants include the high explosives synthesis facility, the explosive burning operation, miscellaneous laboratories, and other small operations (appendix table B.1.3.5–2). With the exception of high explosives disposal burning at the Burning Ground, most stationary points of nonradioactive atmospheric releases are from fume hoods and building exhaust systems with high efficiency particulate air (HEPA) filters. The Waste Explosives Treatment/Disposal Facility will replace the open air burning of explosives currently conducted on the Burning Ground. This will reduce the emissions of hazardous/toxic pollutants currently associated with the explosives burning operation. This project will relocate the explosives disposal to a location southeast of the current Burning Ground.

Table 4.5.2.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at Pantex. As shown in the table, with the exception of the 30-minute standards for hydrogen chloride, baseline concentrations are in compliance with applicable guidelines and regulations.

**TABLE 4.5.2.3–1.—*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Pantex Plant, 1991* [Page 1 of 2]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Baseline Concentration ($\mu g/m^3$) |
|---|---|---|---|
| **Criteria Pollutant** | | | |
| Carbon monoxide (CO) | 8-hour | 10,000[a] | 1,352 |
| | 1-hour | 40,000[a] | 7,836 |
| Lead (Pb) | Calendar Quarter | 1.5[a] | 0.07 |
| Nitrogen dioxide ($NO_2$) | Annual | 100[a] | 2 |
| Ozone ($O_3$) | 1-hour | 235[a] | [b] |
| Particulate matter ($PM_{10}$) | Annual | 50[a] | 27 |
| | 24-hour | 150[a] | 114 |
| Sulfur dioxide ($SO_2$) | Annual | 80[a] | 0.03 |
| | 24-hour | 365[a] | 24 |
| | 3-hour | 1,300[a] | 194 |
| **Mandated by Texas** | | | |
| Hydrogen fluoride | 30-day | 0.8[c] | [d] |
| | 7-day | 1.6[c] | [d] |
| | 24-hour | 2.9[c] | 0.69 |
| | 12-hour | 3.7[c] | [d] |
| **Hazardous and Other Toxic Compounds** | | | |
| Acetone | 30-minute[e] | 5,900[c] | 341.1 |
| | Annual | 590[c] | 0.02 |
| Aliphatic hydrocarbons | 30-minute[e] | [f] | 19 |
| | Annual | [f] | <0.01 |
| Aromatic hydrocarbons | 30-minute[e] | [f] | 27.2 |
| | Annual | [f] | <0.01 |
| Aromatic petroleum distillates | 30-minute[e] | 3,500[c] | 13.6 |
| | Annual | 350[c] | <0.01 |
| 2-Butoxyethanol | 30-minute[e] | 1,210[c] | 208.9 |
| | Annual | 121[c] | 0.13 |
| Butyl acetate | 30-minute[e] | 1,850[c] | 87 |
| | Annual | 710[c] | 0.01 |
| Butyl alcohol | 30-minute[e] | 1,220[c] | 31.6 |
| | Annual | 150[c] | 0.01 |
| Chlorodifluoromethane | 30-minute[e] | 18,000[c] | 4.9 |
| | Annual | 1,800[c] | <0.01 |
| Cyanogen | 30-minute[e] | 210[c] | 161.8 |
| | Annual | 21[c] | 0.01 |
| Dichlorodifluoromethane | 30-minute[e] | 49,500[c] | 23.3 |
| | Annual | 4,950[c] | <0.01 |
| Diesel | 30-minute[e] | 90[c] | 2.4 |
| | Annual | 9[c] | <0.01 |

**TABLE 4.5.2.3–1.—*Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Pantex Plant, 1991* [Page 2 of 2]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | Baseline Concentration (μg/m³) |
|---|---|---|---|
| **Hazardous and Other Toxic Compounds** (continued) | | | |
| Epoxy solvent | 30-minute[e] | [f] | 16.5 |
| | Annual | [f] | <0.01 |
| Ethyl alcohol | 30-minute[e] | 18,800[c] | 12.2 |
| | Annual | 1,880[c] | <0.01 |
| Freon TF | 30-minute[e] | [f] | 24.8 |
| | Annual | [f] | 0.02 |
| Hydrocarbons | 30-minute[e] | [f] | 1,812 |
| | Annual | [f] | 0.08 |
| Hydrogen chloride | 30-minute[e] | 75[c] | 232.3 |
| | Annual | 0.1[c] | 0.01 |
| Isopropyl alcohol | 30-minute[e] | 7,856[c] | 127.3 |
| | Annual | 980[c] | 0.02 |
| Methyl alcohol | 30-minute[e] | 2,620[c] | 178.3 |
| | Annual | 262[c] | 0.11 |
| Methyl ethyl ketone | 30-minute[e] | 3,900[c] | 92.8 |
| | Annual | 590[c] | 0.02 |
| Tert-butyl-ether | 30-minute[e] | [f] | 1.9 |
| | Annual | [f] | 0.01 |
| Tetrahydrofuran | 30-minute[e] | 5,900[c] | 29.6 |
| | Annual | 590[c] | 0.02 |
| Toluene | 30-minute[e] | 3,750[c] | 236.2 |
| | Annual | 375[c] | 0.13 |
| 1,1,1-Trichloroethane | 30-minute[e] | 19,100[c] | 8.3 |
| | Annual | 1,910[c] | <0.01 |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane | 30-minute[e] | [f] | 12.6 |
| | Annual | [f] | <0.01 |
| Trichlorotrifluoroethane | 30-minute[e] | 10,000[c] | 7.3 |
| | Annual | 1,000[c] | <0.01 |
| VM&P naphtha | 30-minute[e] | 3,500[c] | 23.3 |
| | Annual | 350[c] | <0.01 |
| Xylene | 30-minute[e] | 3,700[c] | 44.2 |
| | Annual | 435[c] | 0.01 |

[a] Federal standard (40 CFR 50).
[b] Not monitored because the background concentration is insignificant compared with the standard.
[c] State standard.
[d] Not calculated.
[e] 1-hour predicted concentrations were used for 30-minute standard.
[f] No standard.
Source: PX 1992a:10; PX ACB 1991a.

**Acoustic Conditions.** Major noise emission sources within Pantex include various industrial facilities, equipment, and machines. No sound-level measurements have been made around Pantex. At the site boundary, away from most of the industrial facilities at Pantex, noise emitted from the site would be barely distinguishable from background noise levels. However, some noise from explosives detonation can be heard at residences north of the site.

The acoustic environment along the Pantex boundary and at nearby residences away from traffic noise is assumed to be that of a rural location with typical day/night levels in the range of 35 to 50 dBA (EPA 1974a). Traffic is the primary source of noise at the site boundary and at residences near roads. The contribution of plant traffic to traffic noise levels in the area is small. However, traffic noise is expected to dominate sound levels along major roads in the area such as U.S. Route 60. The residents that have the highest potential for being affected by noise from plant traffic along access routes to Pantex are those living along Farm-to-Market Roads 2373 and 683.

Other sources of noise include aircraft, wind, insect activity, and agricultural activity. Except for the prohibition of nuisance noise, neither the State of Texas nor its local governments have established specific numerical environmental noise standards applicable to Pantex.

#### 4.5.2.4 *Water Resources*

This section describes the surface water and groundwater resources at Pantex.

**Surface Water.** There are no streams or rivers at Pantex, and all site water requirements are met by groundwater. All surface water drains to playas, natural closed depressions that collect runoff to form ephemeral lakes. There are six playas associated with Pantex. Playas 1 through 5 are located on the main site, and Pantex Lake (also a playa) is located approximately 3 miles northeast of the main site (figure 4.5.1–1) (PX DOE 1992a).

Playa 1 receives continuous discharges from the Pantex Wastewater Treatment Facility. Building discharges and stormwater runoff are directed to Playas 1, 2, and 4. Playa 3 receives stormwater runoff from the Pantex Burning Ground. Current Pantex activities do not involve Playa 5 or Pantex Lake, although wastewater has been discharged to Pantex Lake in the past. There are also a number of playas adjacent to Pantex that receive drainage from perimeter portions of the site (PX DOE 1992a). Playas recharge groundwater, although the rate of recharge is unknown. The Texas Bureau of Economic Geology is currently conducting a study to determine this rate (PX Battelle 1992a).

Because there are no onsite or nearby flowing streams, floodplains exist only in association with the playas. A previous floodplain assessment concluded that the only incidence of flooding would be at some sites southeast of Playa 3 and some relict World War II bunkers southwest of Playa 4 (PX DOE 1982a). This limited flooding would not affect the operations of Pantex (PX Battelle 1992a). Information about the 500-year flood is unavailable; however, a site-specific assessment is currently being considered that may address the 500-year flood event for Pantex.

**Surface Water Quality.** The NPDES program of the CWA is administered by the EPA in the State of Texas. In addition, discharge of wastewaters to waters defined as "waters of the United States" within the State of Texas requires a wastewater discharge permit from the Texas Natural Resources Conservation Commission in accordance with the Texas Water Code (PX Battelle 1992a).

Pantex submitted a NPDES permit application for Playas 1, 2, and 4 in November 1990, which is still under review by Region 6 of EPA. Pantex also submitted an NPDES stormwater discharge permit application in October 1991 for Playa 3. This application is also under EPA Region 6 review.

The Texas Natural Resources Conservation Commission allows Pantex to discharge wastewaters into Playas 1 and 2. On December 26, 1990, Pantex filed an application to modify its wastewater discharge permit to allow discharge of both industrial wastewater and rainwater runoff into Playa 4. An application for a renewal of the Texas Natural Resources Conservation Commission wastewater discharge permit #2296 is on file and is currently under negotiation.

The Texas Natural Resources Conservation Commission's annual wastewater inspection in 1991 noted two deficiencies with permit requirements, one for

pH excursions in effluent outside of the 6.0 to 9.0 range, and another for no delineation of the extent of the natural clay liner of the playas to indicate permeable areas. Both deficiencies have been corrected.

Surface water monitoring is conducted at all five playas at the main plant and Pantex Lake as well as at Bushland Playa, an offsite control playa used for comparative purposes. There are some differences in the parameters monitored among the playas, but the results of 1991 monitoring activities at Playa 1 are presented as representative of the water quality of the playas at Pantex (table 4.5.2.4–1) (PX DOE 1992a). Bushland playa was dry during 1991. No parameters exceeded applicable water quality criteria.

**Surface Water Rights and Permits.** Water rights in Texas fall under the Doctrine of Prior Appropriations. Under this doctrine, the user who first appropriated water for a beneficial use has priority to use available water supply over a user claiming rights at a later time. Courts also recognize riparian rights legally granted from Spanish-American Agreements. The Texas Natural Resources Conservation Commission is the administrator for water rights and is the permit-issuing authority.

**Groundwater.** Pantex is located on the Texas High Plains aquifer, which is the southernmost extension of a regional aquifer that extends from Texas to South Dakota (PX WDB 1993a). The two principal water-bearing units beneath Pantex and adjacent areas are the Ogallala aquifer and the Dockum Group aquifer (PX DOE 1983a). Deep wells, completed at depths of 600 to 850 feet into the Ogallala Formation, have provided the water supply at Pantex for over 40 years. In 1990, the recoverable volume of water in storage in the Ogallala aquifer was estimated at approximately $136 \times 10^6$ million gallons (417 million acre-feet).

The Ogallala aquifer beneath Pantex has not been classified by EPA. However, it is the only source of drinking water in the area. Depth to water in the Ogallala aquifer ranges from 340 feet at the southern boundary of Pantex to 460 feet at the northern boundary. The saturated thickness of the Ogallala Formation ranges from 50 feet to more than 400 feet and in some areas is capable of producing yields in excess of 1,000 gallons per minute (gpm) (525.6 MGY) (PX DOE 1983a). Estimates of annual recharge rates to the Ogallala aquifer vary from 0.01 to 1.6 inches per year based on earlier studies that investigated slow regional infiltration of precipitation and recent studies that explored percolation of water through playa lakes (Native 1990) and leakage from the Dockum Group aquifer into the Ogallala aquifer (PX WDB 1993a).

The withdrawal of water from the Ogallala aquifer continues to exceed recharge, causing water levels to decline in the Pantex area at a rate of approximately 2 to 5 feet per year. During 1980 to 1990, the city of Amarillo well field north of Pantex experienced up to 60 feet of water-level decline, causing a depression in the groundwater surface northeast of Pantex (PX WDB 1991a). This depression has caused the groundwater flow direction beneath Pantex to shift from the southeast to the present northeast direction (DOE 1991a). Figure 4.5.2.4–1 shows the potentiometric surface of the Ogallala aquifer beneath Pantex.

**Groundwater Quality.** Pantex's groundwater monitoring program includes monitoring wells, onsite Ogallala production wells, and onsite drinking wells distributed throughout the facility. Wells located in the vicinity of the proposed TSS are shown in figure 4.5.2.4–1. Groundwater samples collected from the monitoring wells are analyzed for a standard suite of parameters and constituents, including volatile organics, high explosives, pesticides, herbicides, semi-volatile organics, trace metal, radioactive materials (gross alpha and gross beta), and field parameters (total dissolved solids and pH).

The groundwater of the perched zone and the Ogallala aquifer beneath Pantex is monitored for both organic and radiological constituents. No radiological and only limited metal concentrations have been found in some of the wells monitoring the Ogallala aquifer. Table 4.5.2.4–2 shows the water quality in the Ogallala aquifer. Groundwater samples from the perched zone, however, contain a variety of constituents that are either above background levels or drinking water standards or not naturally occurring. These include: 1,2-dichloroethane; chromium; iron; and the RDX and HMX (PX DOE 1991d). Table 4.5.2.4–3 shows the water quality in the

**TABLE 4.5.2.4–1.—*Summary of Surface Water Quality Monitoring at Pantex Plant***

| | Receiving Water: Playa 1, 1991 | | |
|---|---|---|---|
| **Parameter** | **Unit of Measure** | **Water Quality Criteria[a]** | **Average Water Body Concentration** |
| Alpha (gross, dissolved) | pCi/l | 15[b] | 6.09 |
| Alpha (gross, suspended) | pCi/l | NA | 3.00 |
| Ammonia (as N) | mg/l | NA | <0.4 |
| Arsenic | mg/l | 0.05[c] | <0.011 |
| Barium | mg/l | 1[c] | <0.18 |
| Beta (gross, dissolved) | pCi/l | 50[d] | 20.70 |
| Beta (gross, suspended) | pCi/l | NA | 5.64 |
| Cadmium | mg/l | 0.005[b] | <0.005 |
| Chloride | mg/l | 250[e] | 89 |
| Chromium | mg/l | 0.1[b] | <0.008 |
| Copper | mg/l | 1.3[b] | <0.009 |
| Cyanide | mg/l | 0.2[b] | <0.005 |
| Fluoride | mg/l | 2.0[c] | 2.1 |
| HMX* | mg/l | NA | <0.020 |
| Iron | mg/l | 0.3[e] | 5.5 |
| Lead | mg/l | 0.015[b] | <0.006 |
| Manganese | mg/l | 0.05[e] | 0.35 |
| Mercury | mg/l | 0.002[b] | <0.0001 |
| Oil and grease | mg/l | NA | <1 |
| PETN* | mg/l | NA | <0.40 |
| Plutonium-239, -240 | pCi/l | 1.2[f] | 0 |
| Radium-226 | pCi/l | 4.0[f] | 0.60 |
| Radium-228 | pCi/l | 4.0[f] | 1.10 |
| RDX* | mg/l | NA | <0.020 |
| Selenium | mg/l | 0.01[c] | <0.005 |
| Silver | mg/l | 0.05[c] | <0.005 |
| Sulfate (as $SO_4$) | mg/l | 250[e] | <11 |
| TNT* | mg/l | NA | <0.020 |
| Total organic carbon | mg/l | NA | 20 |
| Tritium | pCi/l | 20,000[b] | 70 |
| Uranium-234 | pCi/l | 20[f] | 4.26 |
| Uranium-238 | pCi/l | 24[f] | 2.20 |
| Zinc | mg/l | 5[e] | <0.025 |

[a] For comparison only, except for parameters that have Texas state water quality criteria.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] Texas state water quality criteria. Parameters are considered in exceedance only when their concentrations surpass state water quality criteria. General criteria do not apply to instances in which surface water, as a result of natural phenomena, exhibit characteristics beyond the limits established.

[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[e] National Secondary Drinking Water Regulations (40 CFR 143).

[f] DOE Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored concentration. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the environmental level and there is no significant impact from the facility.

Note: * Denotes high explosive(s) compounds.

Note: < Less than symbol indicates concentration below the analysis detection limit.

Note: NA - not applicable.

Source: DOE 1993u.

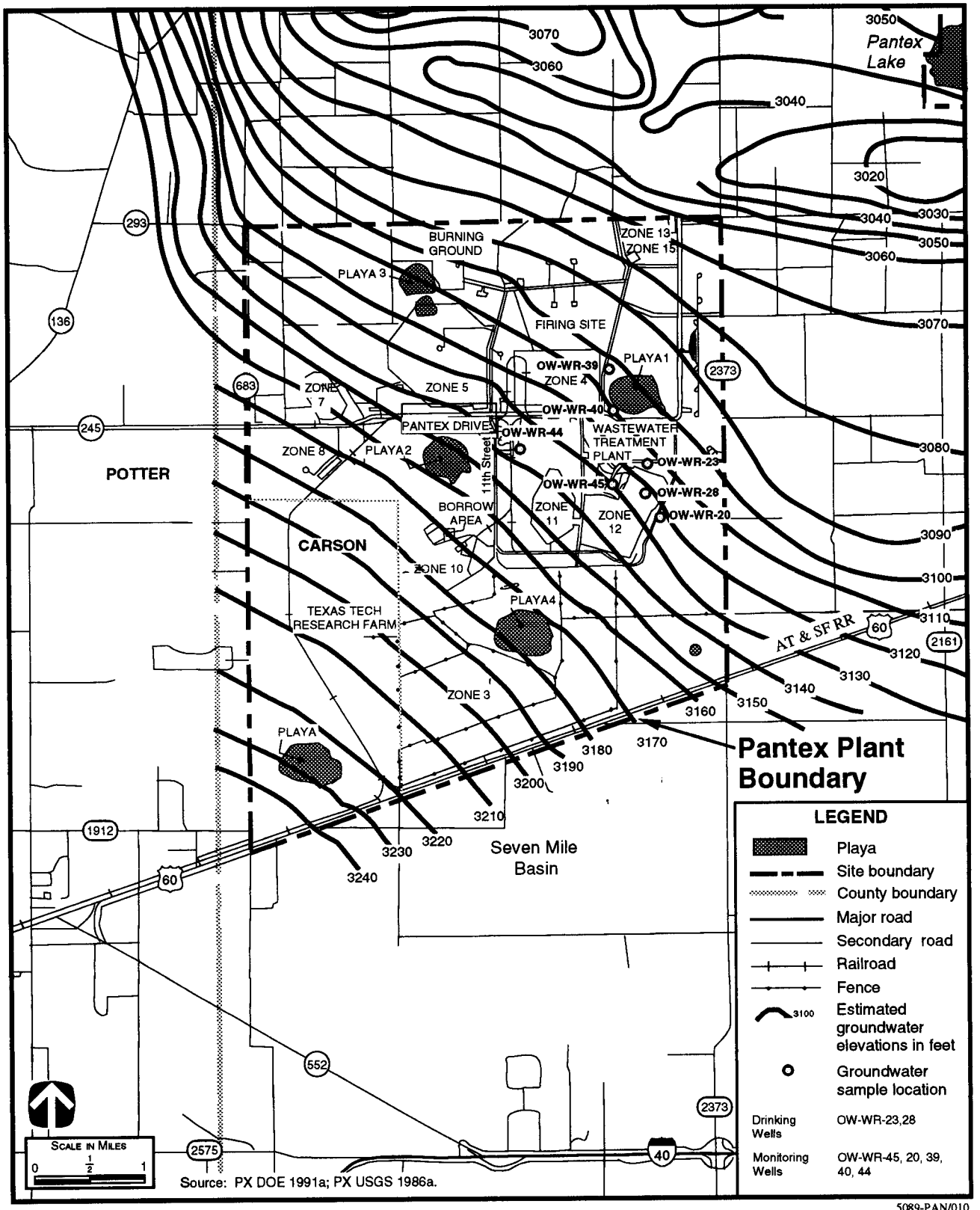



**FIGURE 4.5.2.4–1.**—*Potentiometric Surface of the Ogallala Aquifer at Pantex Plant.*

**TABLE 4.5.2.4–2.—*Groundwater Quality Monitoring (Ogallala Aquifer Wells) at Pantex Plant***

| Parameter | Unit of Measure | Water Quality Criteria and Standards[a] | Existing Conditions (1990) | | | |
|---|---|---|---|---|---|---|
| | | | Drinking Water | | Monitoring | |
| | | | Well No. WR-23 | Well No. WR-28 | Well No. WR-39 | Well No. WR-40 |
| Alpha (gross) | pCi/l | 15[b] | 0-2 | 0 | 0-3 | 0 |
| Barium | mg/l | 2.0[b] | 0.11-0.14 | 0.11-0.14 | 0.01-0.15 | 0.3-0.16 |
| Beta (gross) | pCi/l | 50[c] | 0-2 | 0-1 | 0-2 | 0-1 |
| Chromium | mg/l | 0.1[b] | <0.005-0.007 | <0.005-0.009 | <0.005 | <0.005-0.006 |
| Copper | mg/l | 1.3[b] | 0.038-0.910 | <0.005-0.021 | <0.005-0.005 | <0.005-0.006 |
| 1,2 Dichloroethane | mg/l | 0.005[b] | <0.005 | <0.005 | <0.005 | <0.005 |
| HMX | mg/l | NA | <0.020 | <0.020 | <0.020 | <0.020 |
| Iron | mg/l | 0.3[d] | <0.01-0.19 | <0.01-0.03 | 0.26-2.70 | 0.12-2.10 |
| Lead | mg/l | 0.015[b] | <0.005-0.022 | <0.005-0.028 | <0.005-0.066[e] | <0.005 |
| Nitrate | mg/l | 10[b] | 1.2-1.5 | 1.3-1.5 | 0.75-1.4 | 1.1-1.3 |
| pH | pH units | 6.5-8.5[d] | 7.8 | 7.8 | 7.7 | 7.8 |
| RDX | mg/l | NA | <0.020 | <0.020 | <0.020 | <0.020 |
| Sulfate | mg/l | 250[d] | 18-19 | 18-22 | 9-21 | 11-21 |
| Total dissolved solids | mg/l | 500[d] | 288 | 292 | 273 | 288 |
| Total organic carbons | mg/l | NA | [f] | [f] | <1.0-7 | <1-24 |
| Total organic halogens | mg/l | NA | [f] | [f] | <3,000-10,000 | <3,000-24,000 |
| Trichloroethylene | mg/l | 0.005[b] | <0.005 | <0.005 | <0.005 | <0.005 |
| Tritium | pCi/l | 20,000[b] | 30-150 | 20-250 | 120-220 | 20-300 |
| Uranium-233, -234, -235, -238 | pCi/l | 20[g] | 1.5-2.4 | 1.7-1.9 | 1.6-2.2 | 1.8-2.4 |
| Zinc | mg/l | 5[d] | 0.023-0.160 | 0.042-0.110 | 0.61-10 | 0.170-1.30 |

[a] For comparison only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] The maximum contaminant level for lead cited has been replaced by a treatment criteria based on statistical methods. Drinking water requires treatment if the 90th percentile level of lead concentration exceeds the action level concentration of 0.015 mg/l. Eleven samples were taken in 1990, the 90th percentile concentration was 0.009 mg/l, below the action level of 0.015 mg/l. The water from WR-39 and the Ogallala aquifer would, therefore, meet the drinking water criteria.
[f] Not sampled.
[g] DOE Derived Concentration Guides for water (DOE Order 5400.5). Number used is 4 percent of Derived Concentration Guides.
Note: NA - not applicable.
Source: PX MH 1991c.

perched zone. No maps of the perched zone contaminant levels are currently available as to the extent of contamination.

**Groundwater Availability, Use, and Rights.** Five production wells in the northeast corner of Pantex serve the plant's industrial and potable water needs. In 1991, the plant pumped 303 million gallons of water from the Ogallala aquifer, while the city of Amarillo pumped 4.9 billion gallons from its well field located immediately north of the plant. The estimated sustainable groundwater producing capacity of the Ogallala is approximately 0.53 BGY. Pantex Lake, located adjacent to the Amarillo water-well field, is available for drilling additional water wells if needed for future operations.

The Ogallala Formation is also the source for municipal and industrial water to nearby towns and cities and irrigation water to nearby farms. In the

**TABLE 4.5.2.4–3.—*Groundwater Quality Monitoring (Perched Zone Wells) at Pantex Plant***

| Contaminant | Unit of Measure | Water Quality Criteria and Standards[a] | Existing Conditions (1990) | | |
|---|---|---|---|---|---|
| | | | Well No. WR-44 | Well No. WR-45 | Well No. WR-20 |
| Alpha (gross) | pCi/l | 15[b] | 0-1 | 0-1 | 0-5 |
| Barium | mg/l | 2[b] | 0.12-0.17 | 0.19-0.23 | 0.13-0.18 |
| Beta (gross) | pCi/l | 50[c] | 0-1 | 0-2 | 0-2 |
| Chromium | mg/l | 0.1[b] | <0.005-0.005 | <0.005-0.014 | 0.062-0.120 |
| Copper | mg/l | 1.3[d] | <0.005-0.003 | <0.005-0.005 | <0.005-0.003 |
| 1,2 Dichloroethane | mg/l | 0.005[b] | <0.005 | <0.005 | <0.005-0.010 |
| HMX | mg/l | NA | <0.020 | <0.020 | <0.020-0.083 |
| Iron | mg/l | 0.3[d] | 0.01-0.09 | <0.04-0.21 | <0.005-5.00 |
| Lead | mg/l | 0.015[b] | <0.005 | <0.005 | <0.005 |
| Nitrate | mg/l | 10[b] | 0.83-2.10 | 0.93-1.30 | 1.80-2.70 |
| pH | pH units | 6.5-8.5[d] | 7.8 | 7.6 | 7.8 |
| RDX | mg/l | NA | <0.020 | <0.020 | 0.73-2.40 |
| Sulfate | mg/l | 250[d] | 6-15 | 13-25 | 16-27 |
| Total dissolved solids | mg/l | 500[d] | 190-230 | 380-430 | 270-340 |
| Total organic carbons | mg/l | NA | <0.005 | 1-5.0 | <1.0-5.6 |
| Total organic halogens | mg/l | NA | <3,000-21,000 | 5,000-36,000 | 19,000-40,000 |
| Trichloroethylene | mg/l | 0.005[b] | <0.005 | <0.005 | <0.005 |
| Tritium | pCi/l | 20,000[b] | 60-220 | 20-200 | 0-160 |
| Uranium-233, -234, -235, -238 | pCi/l | 20[e] | 0.8-1.6 | 2-2.6 | 0.8-4.9 |
| Zinc | mg/l | 5[d] | 0.013-0.970 | 0.006-1.30 | <0.005-0.040 |

[a] For comparison only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] DOE Derived Concentration Guides for water (DOE Order 5400.5). Number used is 4 percent of Derived Concentration Guides.
Note: NA - not applicable.
Source: PX MH 1991c.

Pantex area, the cities of Amarillo and Canyon maintain community water systems. The city of Amarillo draws its raw water from groundwater and Lake Meredith and has the capacity to supply 75 MGD. The city of Canyon maintains the capacity to supply approximately 7 MGD from its own wells and may purchase up to 5 MGD from the city of Amarillo.

Groundwater is controlled by the individual landowner in Texas. The Texas Department of Health and the Texas Water Development Board are the two state agencies with major involvement in groundwater fact finding, data gathering, and analysis. Groundwater management is the responsibility of local jurisdictions through Groundwater Management Districts. The Pantex facility is located in Panhandle Groundwater District 3, which has the authority to require permits and limit the quantity of water pumped. Presently, the Panhandle Groundwater District does not limit the quantity of water pumped.

### 4.5.2.5 *Geology and Soils*

**Geology.** Pantex is located on the southern High Plains of the Texas panhandle. The topography at Pantex consists of flat to gently rolling plains. There are no unique landforms, and the only distinctive features are playas that are spaced more or less uniformly over the site. The playas are about 1,500 to 2,000 feet across with clay bottoms and depths to 30 feet.

The site itself is underlain by the Blackwater Draw Formation. At Pantex this geologic formation consists of a sequence of buried soils with an upper unit of mostly silt, clay, and caliche and a 20-foot lower unit of silty sand with caliche. The Ogallala Formation underlies the Blackwater Draw Formation.

No capable faults within the definition of 10 CFR 100, Appendix A, are present in the vicinity of Pantex. The plant is located at the edge of a large Permian fault block, but there is no indication of faulting in the immediate area in the last 250 million years.

Pantex lies on the boundary between Seismic Zones 0 and 1, indicating no damage to minor damage could occur as a result of earthquakes (figure 4.2.2.5–2). Since 1906, only nine earthquakes of Richter magnitude 3.0 or greater have been recorded in the more seismically active Amarillo Highlands 20 miles northeast of Pantex. Seismicity in the Palo Verde Basin and at Pantex is low. There is no volcanic hazard at Pantex.

**Soils.** Pantex is underlain by soils of the Pullman-Randall association. These soils are typically deep, very low permeability clays and clay loams. Pullman soils underlie most of the plant area, but Randall soils occur in the vicinity of the playas and depressions. Water and wind erosion and shrink-swell potential is moderate to severe for most of the soil units (PX USDA 1962a; PX USDA 1980a). However, the soils are acceptable for standard construction techniques.

#### 4.5.2.6 *Biotic Resources*

The following description of biotic resources at Pantex includes terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Scientific names of species identified in the text are presented in appendix C. Also presented in that appendix is a list of threatened and endangered species that may occur on the site or in the vicinity of Pantex.

**Terrestrial Resources.** Pantex is located within a treeless portion of the High Plains that is classified as mixed prairie. The High Plains vegetational area is a southern extension of the short- and mid-grass prairies of the Western Great Plains. The primary vegetation of the High Plains includes short-grasses (i.e., buffalo-grass and blue grama) and mid-grasses (i.e., little bluestem, sideoats grama, and western wheatgrass) (PX DOE 1991a). Twenty-three percent of the site, including land leased from Texas Tech University, has been developed (PX 1992a:5). Much of the remainder of the site has been disturbed by past agricultural practices, and is currently being managed as native and improved pasture or cultivated by the University or its tenant farmers (PX DOE 1983a). Small areas of undisturbed vegetation, primarily grasses and herbs, exist around playas. Plant communities on the site have not been mapped (PX 1992a:6).

Surveys of amphibians, reptiles, birds, and mammals occurring on Pantex are in progress. Common bird species known to occur in the vicinity of Pantex include the western meadowlark, mourning dove, horned lark, and several species of sparrows. Common species of mammals found in the vicinity of Pantex include the black-tailed jackrabbit, black-tailed prairie dog, and hispid cotton rat (PX 1994a:1; PX DOE 1991a). Among the game animals occurring onsite are cottontails, scaled and bobwhite quail, mourning dove, and numerous waterfowl species (PX 1994a:1). Hunting is not permitted at Pantex (PX 1992a:5). Common raptors on Pantex include the red-tailed hawk, American kestrel, and burrowing owl (PX DOE 1994b). Carnivores present include the badger and coyote. A variety of migratory birds has been found at Pantex. Migratory birds, their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

**Wetlands.** Wetlands at Pantex are associated with the five playa basins occurring on the site (figure 4.5.1–1), and Pantex Lake (also a playa), located approximately 3 miles northeast of the site. The National Wetland Inventory map identifies playas 1 through 5 and part of Pantex Lake as wetlands (PX DOI nda). Playas 1, 2, and 3 are classified by the USFWS as palustrine (non-tidal wetlands dominated by trees, shrubs, and emergent vegetation) systems. The larger playas, 4 and 5, and Pantex Lake are classified as lacustrine (lakes, ponds, and other enclosed open waters at least 20 acres in extent and not dominated by trees, shrubs, or emergent vegetation) systems. Playas 1, 2, and 4 currently receive

wastewater discharge (section 4.5.3.4). There are numerous smaller wetlands (approximately 10 acres or less) located on western and southwestern parts of Pantex in areas that are largely grazed or farmed (PX 1992a:4; PX DOI nda). These wetlands are classified as palustrine systems. Two of these wetlands are located near the southern-most proposed TSS. Situated along the Central Flyway Migratory Route, the Pantex playas are important to migratory birds and provide valuable habitat for nesting and wintering birds and waterfowl.

**Aquatic Resources.** Aquatic habitat at Pantex is limited to four ephemeral playas, one permanent playa, and several ditches (figure 4.5.1–1). Although the playas and ditches may provide habitat for amphibians and macroinvertebrates, they do not support any fish populations (PX 1992a:5). Pantex Lake, located 3 miles northeast of the site, also does not contain any fish (PX 1992a:8).

**Threatened and Endangered Species.** Eighteen Federal- or state-listed threatened, endangered, and special status species have been identified on and in the vicinity of Pantex (appendix table C–5). Table 4.5.2.6–1 lists the species (including two subspecies of peregrine falcon) that may occur on or near the proposed TSS. Field surveillance would be required to determine their presence. No critical habitat for threatened and endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on Pantex.

The bald eagle is a winter resident that has been observed foraging at playas on the site each year. The whooping crane, an infrequent migrant in the Texas panhandle, was observed foraging onsite and in the surrounding area in the fall of 1990 (PX 1992a:3). Migratory peregrine falcons (undetermined subspecies) have been observed hunting shorebirds and waterfowl near area playas (PX 1992a:2).

Federal candidate species observed on Pantex include the swift fox, black tern, ferruginous hawk, loggerhead shrike, white-faced ibis, and Texas horned lizard. Possible swift fox dens have been found on Pantex. The Texas horned lizard is known to reside on the site and the loggerhead shrike is a common permanent resident which probably nests onsite. The ferruginous hawk forages in shortgrass prairie, and the black tern and white-faced ibis forage at the playas.

**TABLE 4.5.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May be Found on the Site or In the Vicinity of Proposed Tritium Supply Site on Pantex Plant***

| Species | Status[a] | | Potential Habitat/Location |
|---|---|---|---|
| | Federal | State | |
| **Mammals** | | | |
| Swift fox[b] | C2 | NL | Open plains |
| **Birds** | | | |
| American peregrine falcon[c] | E | E | Forages at playas, migrant |
| Arctic peregrine falcon | T | T | Forages at playas, migrant |
| Bald eagle[b,c] | E | E | Playa, winter resident |
| Black tern[b] | C2 | NL | Forages at playas, migrant |
| Ferruginous hawk[b] | C2 | NL | Forages in shortgrass prairie |
| Loggerhead shrike[b] | C2 | NL | Semi-open areas with lookout perch |
| White-faced ibis[b] | C2 | T | Forages at playas |
| Whooping crane[b,c] | E | E | Forages at playas, rare migrant |
| **Reptiles** | | | |
| Texas horned lizard[b] | C2 | ST | Arid open country |

[a] Status code: C2 - candidate Category 2 (possibly appropriate to list); E - endangered; NL - not listed; ST - state, threatened (animals); T - threatened.

[b] Species observed on the Pantex Plant.

[c] USFWS Recovery Plan exists for this species.

Source: 50 CFR 17.11; 50 CFR 17.12; PX 1992a:2; PX 1994a:1; PX DOE 1994b; PX MH 1994c; PX PWD 1991b; PX PWD 1993a; PX PWD 1993b; PX WTS 1992a.

There is little undisturbed habitat at Pantex that would accommodate any of the threatened, endangered, and other special status species listed in table 4.5.2.6–1. Most of these species are attracted to the playas, which provide water and foraging habitat. According to a recent floristic survey (PX DOE 1993c), there are no Federal- or state-listed plant species known to occur on Pantex. However, there are three cactus species at Pantex that may be proposed for a watchlist of potentially threatened plant species.

#### 4.5.2.7 *Cultural and Paleontological Resources*

**Prehistoric Resources.** Prehistoric site types identified at Pantex include small temporary campsites and limited activity locations characterized by surface scatters of artifacts. Archaeological surveys at Pantex have systematically covered approximately one-third of the facility. Fifty-five prehistoric sites have been recorded, some of which contain heat-altered rock that suggests food processing. These prehistoric campsites tend to be clustered near the Pantex playas. Twenty-three sites have been tested, but have not been evaluated for eligibility to the NRHP. Prehistoric sites are not specifically known in the proposed project locations, though some possibility of their presence exists.

**Historic Resources.** The Pantex facility was originally constructed in 1942, as a World War II bomb-loading plant on land claimed from local farmers. Remains of nearly a dozen of these farmsteads have been recorded as historic archaeological sites, none of which have been evaluated for NRHP eligibility. One of these is located within proposed Industrial Site C (figure 4.5.2.1–3). Additional sites are possible in the project areas, but are not likely.

The entire Pantex site has been surveyed for World War II-era structures and foundations, and all such properties systematically recorded. However, no final determinations of NRHP eligibility have been made. It is likely that 60 to 80 of these properties will be eligible, either as individual structures or as contributing properties to a World War II-era historic district. No World War II-era properties are in the proposed industrial sites for this project.

The Cold War/Nuclear Technology historic context has not yet been defined for Pantex. When this occurs, it is virtually certain that a number of plant structures will be determined NRHP-eligible.

**Native American Resources.** Historic Native American groups known to have occupied or used the Pantex region included Apache, Arapaho, Caddo, Cheyenne, Comanche, Delaware, Kiowa, and Wichita. Native American resources associated with these groups have not yet been identified at Pantex, but the remains of temporary campsites, hunting locations, ceremonial locations, or isolated burials are possible.

**Paleontological Resources.** The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the High Plains this formation contains late Pleistocene vertebrate remains, including bison, camel, horse, mammoth, and mastodon, with occasional and significant evidence of their use by early humans. Evidence of woolly mammoth has recently been found north of Pantex (PX 1992a:7), and a recent archaeological testing program at the Pantex Plant recovered possible bison bones eroding from small incised drainages near playas. These remains have not yet been positively identified as paleontological or cultural materials.

#### 4.5.2.8 *Socioeconomics*

Socioeconomic characteristics addressed at Pantex include employment and local economy, population, housing, public finance, and local transportation. Statistics for employment and local economy are based on the economic study area that encompasses 15 counties around Pantex. The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for the remaining socioeconomic characteristics are based on the ROI, a 3-county area in which 90 percent of all Pantex employees reside: Carson County (5 percent) and Potter and Randall Counties (85 percent). (See figure 4.5–1 for a map of counties and cities). Fiscal characteristics of the jurisdictions in the Pantex ROI are presented in the public finance section in appendix tables D.3–62 and D.3–63. The independent school districts most likely to be affected by the proposed action include Groom, Panhandle, White Deer, Amarillo, and Canyon. Assumptions, assessment methodologies, and supporting data are presented in appendix D.

**Employment and Local Economy.** Employment and local economy statistics for the Pantex economic study area are presented in appendix table D.3–53, and summarized in figure 4.5.2.8–1. Between 1970 and 1990, the civilian labor force in the economic study area increased approximately 43 percent. The unemployment rate in the economic study area in 1990 was lower than that of the state rate. The 1990 per capita income in the economic study area was approximately 6 percent higher than the Texas per capita income.

As shown in figure 4.5.2.8–1, the percentage of total employment involving farming and governmental activities in the economic study area was approximately the same as the percentage for the state. Nonfarm private sector activities of manufacturing, retail trade, and services in the economic study area were greater than the state.In 1990, Pantex employed 2,394 persons (1.6 percent of the total economic study area employment), increasing from 1,630 persons in 1970. Historical and future employment at Pantex and the distribution of Pantex employees by place of residence in the ROI are presented in appendix tables D.2.1–1 and D.3–52, respectively.

**Population and Housing.** Population and housing distribution in the ROI is presented in appendix tables D.3–56 and D.3–59, and summarized in figure 4.5.2.8–2. The percent increase in population in the ROI from 1970 to 1990 was approximately half the state percent increase except for Randall County, which experienced a 66-percent increase. The percentage increase in housing units in the ROI between 1970 and 1990 was approximately 28 percent lower than the state increase except for Randall County, which experienced a 118-percent increase. Homeowner and rental vacancy rates in the ROI in 1990 were similar to those experienced by the state.

**Public Finance.** Financial characteristics of the local jurisdictions in the Pantex ROI that are most likely to be affected by the proposed action include total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capital project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.3–62 and D.3–63, and figure 4.5.2.8–3 summarizes local government's revenues less its expenditures.

**Local Transportation.** Vehicular access to Pantex is provided by Farm-to-Market Roads 683 to the west and 2373 to the east. Both roads connect with Farm-to-Market Road 293 to the north and U.S. Highway 60 to the south (figure 4.5–1). Road segments providing access to Pantex experience varying levels of service. Traffic on State Route 60 generally experiences slightly more congestion than other access routes. Potential disruptions to the traffic flow caused by accidents or maintenance activities are usually minor. No major improvements are scheduled for roadway segments providing immediate access to Pantex (figure 4.5.1–1).

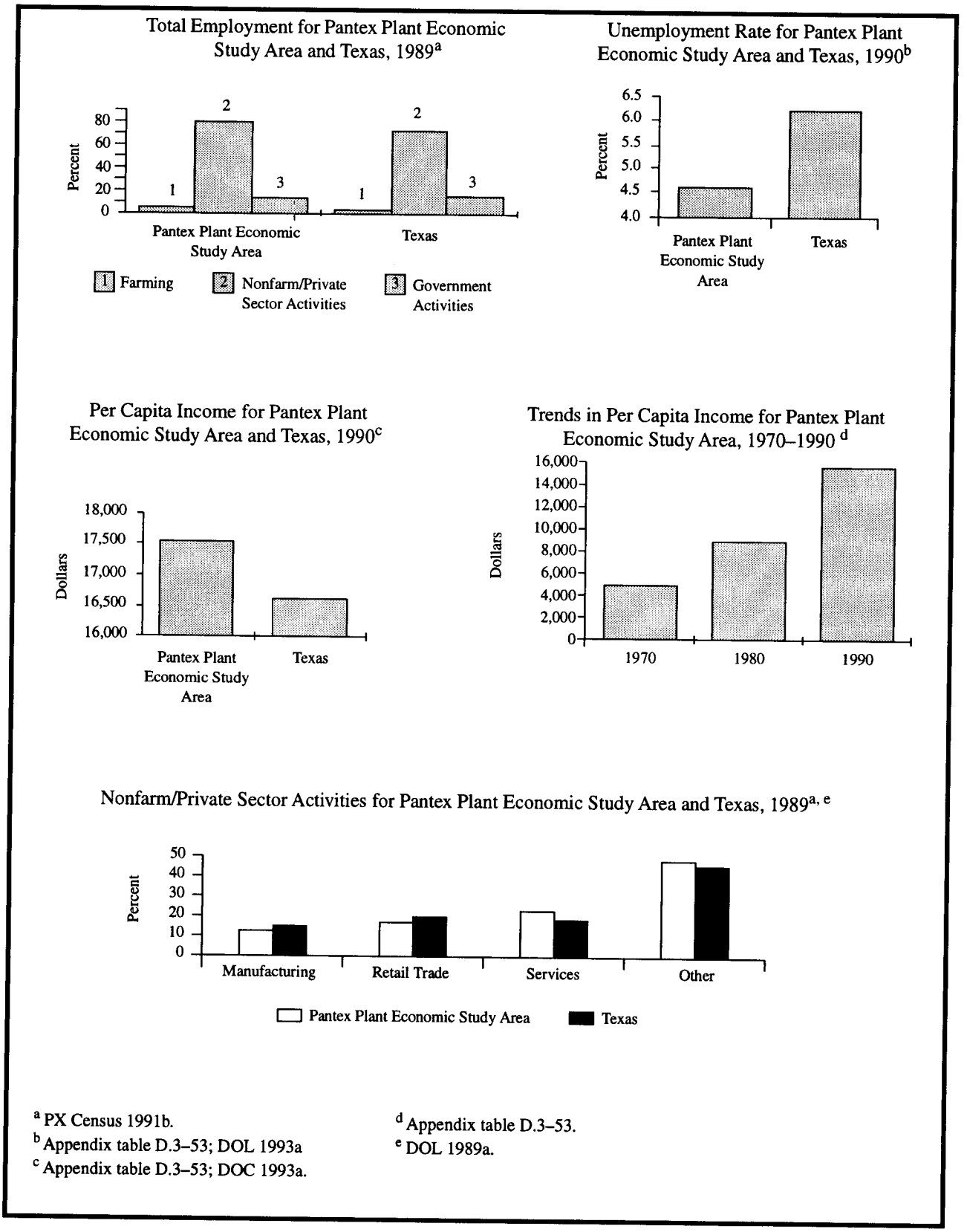
Amarillo receives public transport service from Amarillo City Transit; however, no service is provided to Pantex. Major railroads in the Pantex ROI include the Burlington-Northern Railroad and the Atchison, Topeka and Santa Fe Railroad. The mainline of the Atchison, Topeka, and Santa Fe Railroad parallels the southern boundary of Pantex and provides direct access to the site. There are no navigable waterways within the ROI capable of accommodating material transports to the plant.

Amarillo International Airport receives jet air passenger and cargo service from national and local carriers. Several smaller private airports are located throughout the ROI (DOT 1991a).

### 4.5.2.9 *Radiation and Hazardous Chemical Environment*

The following provides a description of the radiation and hazardous chemical environment at Pantex. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

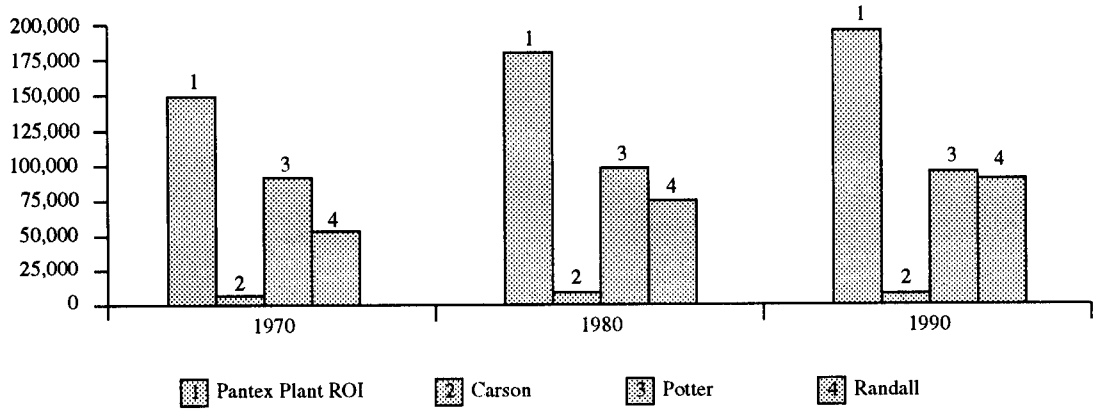
**Radiation Environment.** Major sources of background radiation exposure to individuals in the vicinity of Pantex are shown in table 4.5.2.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of



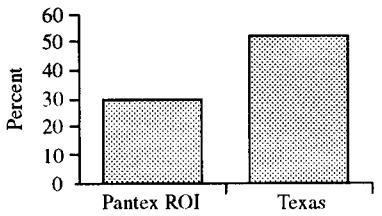

[a] PX Census 1991b.
[b] Appendix table D.3–53; DOL 1993a
[c] Appendix table D.3–53; DOC 1993a.
[d] Appendix table D.3–53.
[e] DOL 1989a.

**FIGURE 4.5.2.8–1.—*Economy for Pantex Plant Economic Study Area.***

Trends in Population for Pantex Plant ROI and Counties, 1970–1990[a]




Increase in Population for Pantex Plant ROI and Texas, 1970-1990[a]




Change in Population for Pantex Plant ROI and Counties, 1970–1990[a]

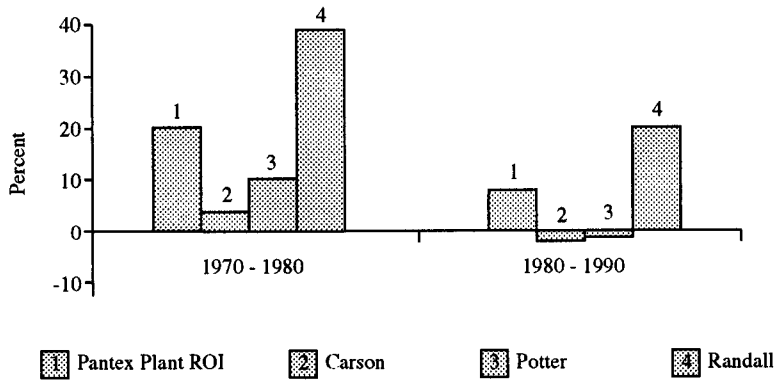
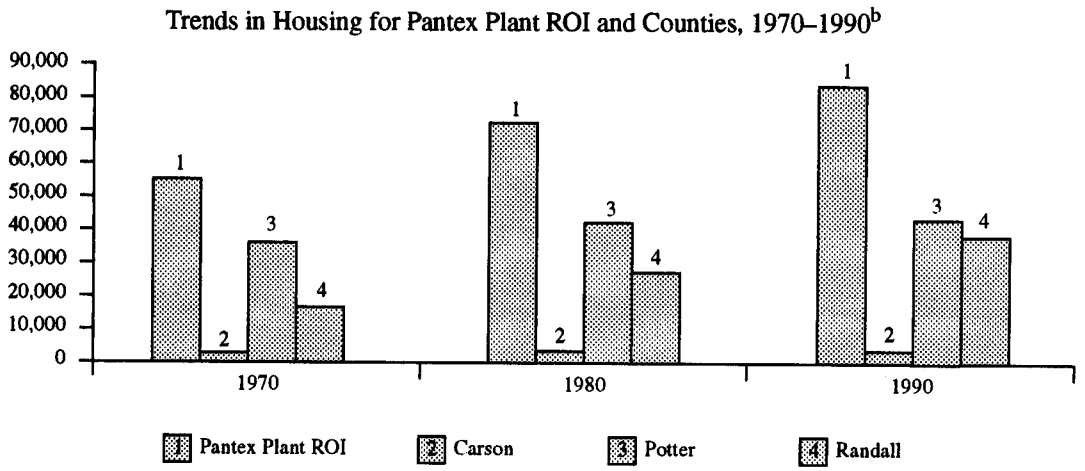
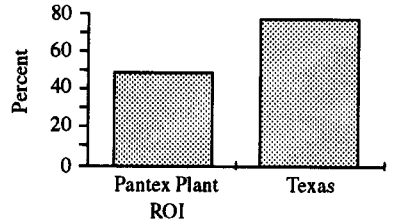
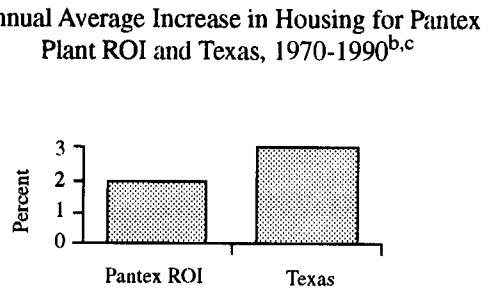
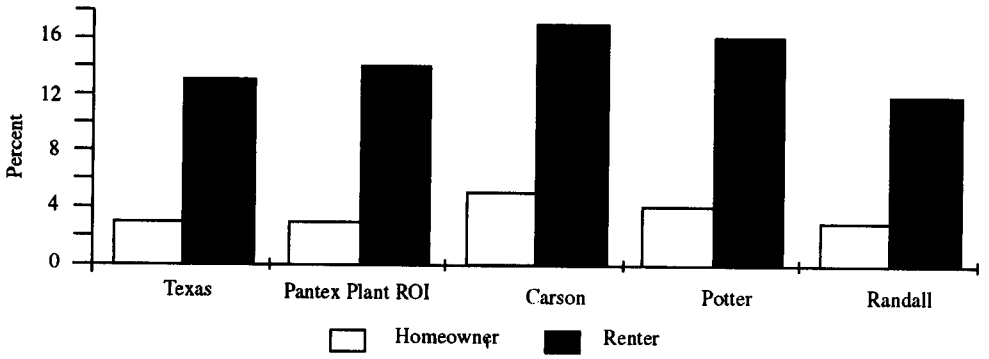



**FIGURE 4.5.2.8–2.—*Population and Housing for Pantex Plant Region-of-Influence* [Page 1 of 2].**



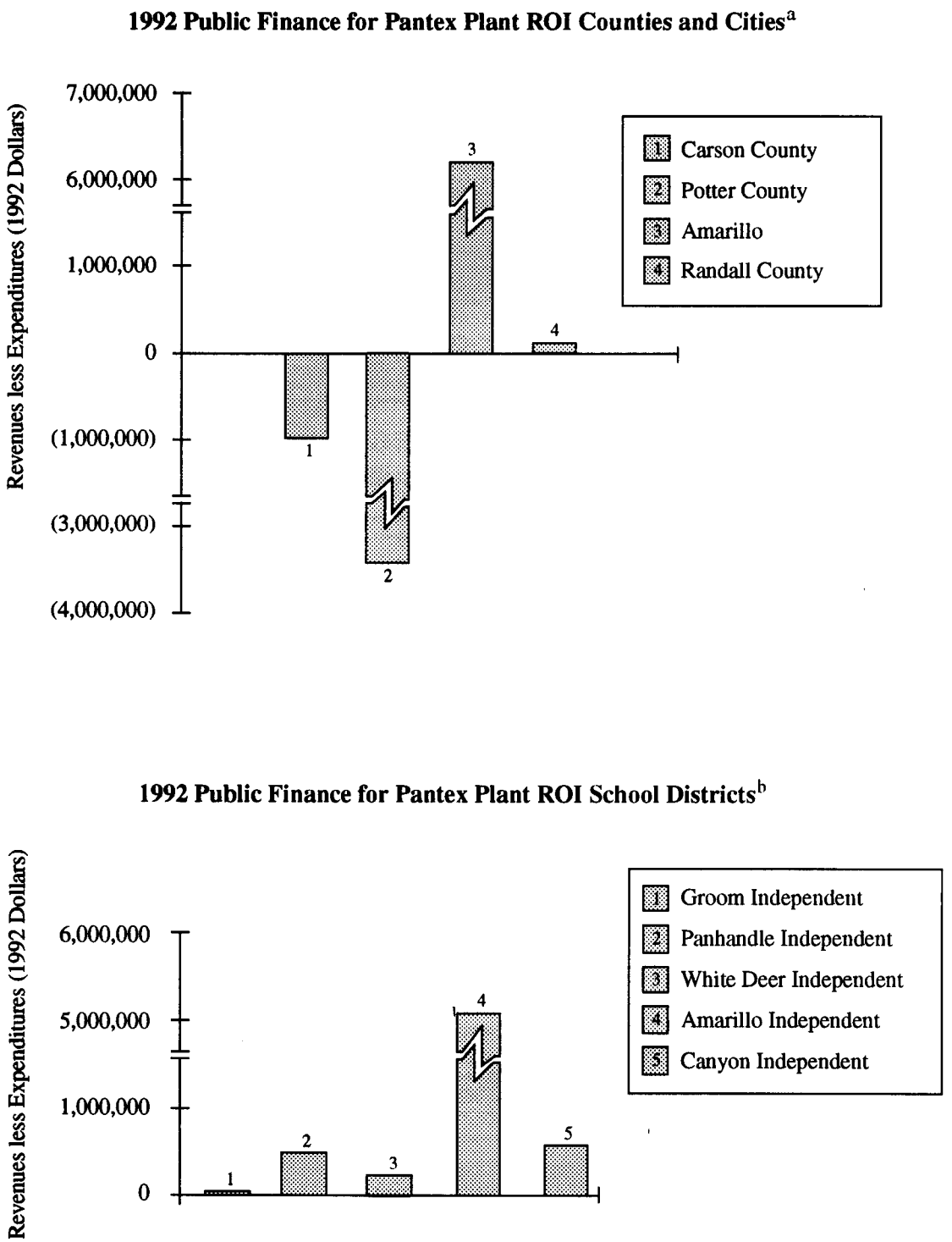




[a] Appendix table D.3–56.
[b] Appendix table D.3–59.
[c] Census 1972a; Census 1982a; PX Census 1991a.

**FIGURE 4.5.2.8–2.—*Population and Housing for Pantex Plant Region-of-Influence* [Page 2 of 2].**




[a] PX City 1992a; PX County 1992a.
[b] PX School 1992a.

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**FIGURE 4.5.2.8–3.—*1992 Local Government Public Finance for Pantex Plant Region-of-Influence.***

**TABLE 4.5.2.9–1.—*Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Pantex Plant Operations***

| Source | Committed Effective Dose Equivalent (mrem/yr) |
|---|---|
| **Natural Background Radiation**[a] | |
| Cosmic and external terrestrial cosmogenic radiation | 107 |
| Internal terrestrial radiation | 39 |
| Radon in homes (inhaled) | 200 |
| **Other Background Radiation**[b] | |
| Diagnostic X-rays and nuclear medicine | 53 |
| Weapons test fallout | <1 |
| Air travel | 1 |
| Consumer and industrial products | 10 |
| **Total** | 411 |

[a] From NCRP 1987a; PX Battelle 1993a. Value for radon is an average for the United States.
[b] NCRP 1987a.

the population. Background radiation doses are unrelated to Pantex operations.

Releases of radionuclides to the environment from Pantex operations provide another source of radiation exposure to people in the vicinity of Pantex. The radionuclides and quantities released from Pantex operations in 1992 are listed in the *Pantex Plant Site Environmental Report for Calendar Year 1992* (RPT7). The doses to the public resulting from these releases are given in table 4.5.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1992 report were used in the development of the reference environment (No Action) radiological releases at Pantex in the year 2010 (section 4.5.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (appendix section E.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Pantex operations in 1992 is estimated to be approximately $1.4 \times 10^{-11}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of Pantex operations is less than 14 chances in 1 trillion. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Approximately $2.5 \times 10^{-8}$ excess fatal cancers were estimated from normal operations in 1992 to the population living within 50 miles of Pantex. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the U.S. population was 0.2 percent per year (Almanac 1993a). Based on this mortality rate, the number of fatal cancers from all causes expected to occur during 1992 in the population living within 50 miles of Pantex was 550. This number of expected fatal cancers is much higher than the estimated $2.5 \times 10^{-8}$ fatal cancers that could result from Pantex operations in 1992.

Workers at Pantex receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.5.2.9–3 includes the average, maximum, and total occupational doses to Pantex workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (appendix section E.2), the number of excess fatal cancers to Pantex workers from operations in 1992 is estimated to be 0.020.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Pantex Plant Site Environmental Report for Calendar Year 1992* (RPT7). In addition, the concentrations of radioactivity in various environmental media (e.g., air, water, soil) in the site region (onsite and offsite) are presented in the same reference. Pantex operations contribute only small amounts of radioactivity to all these media. Past discharges to Playa 1 (see figure 4.5.1–1) were substantial. However, this playa is located onsite and is not used as a drinking water source. Appropriate monitoring is conducted to ensure that contamination from this playa will not reach drinking water supplies.

**Chemical Environment.** The background chemical environment important to human health consists of:

**TABLE 4.5.2.9–2.—*Doses to the General Public from Normal Operation at Pantex Plant, 1992 (committed effective dose equivalent)***

| | Atmospheric Releases | | Liquid Releases | | Total | |
|---|---|---|---|---|---|---|
| **Affected Environment[a]** | **Standard[b]** | **Actual** | **Standard[b]** | **Actual** | **Standard[b]** | **Actual** |
| Maximally exposed individual (mrem) | 10 | $2.7 \times 10^{-5}$ | 4 | 0.0 | 100 | $2.7 \times 10^{-5}$ |
| Population within 50 miles[c] (person-rem) | None | $5.0 \times 10^{-5}$ | None | 0.0 | 100 | $5.0 \times 10^{-5}$ |
| Average individual within 50 miles[d] (mrem) | None | $1.8 \times 10^{-7}$ | None | 0.0 | None | $1.8 \times 10^{-7}$ |

[a] From PX Battelle 1993a.

[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834. If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[c] In 1992, this population was approximately 275,000.

[d] Obtained by dividing the population dose by the number of people living within 50 miles of the site.

**TABLE 4.5.2.9–3.—*Doses to the Worker Onsite from Normal Operation at Pantex Plant, 1992 (committed effective dose equivalent)***

| | Onsite Releases and Direct Radiation | |
|---|---|---|
| **Affected Environment[a]** | **Standard[b]** | **Actual** |
| Average worker (mrem) | None | 21.1 |
| Maximally exposed worker (mrem) | 5,000 | 1,000 |
| Total workers (person-rem) | None | 51 |

[a] From DOE 1993p. The number of badged workers in 1992 was approximately 2,410.

[b] From 10 CFR 835. DOE's goal is to maintain radiological exposure as low as reasonably achievable.

the atmosphere, which may contain toxic chemicals that can be inhaled; drinking water, which may contain toxic chemicals that can be ingested; and other environmental media with which people may come in contact; e.g., surface waters during swimming and soil through direct contact or via the food pathway. The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.5.2.3 and 4.5.2.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at Pantex via inhalation of air containing pollutants released to the atmosphere by Pantex operations. Risks to public health from other possible pathways such as ingestion of contaminated drinking water or by direct exposure are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous/toxic air pollutants and their applicable standards are presented in section 4.5.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. All annual concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix section E.3.

Health impacts to Pantex workers during normal operation may include those from inhalation of the workplace atmosphere, drinking Pantex potable water, and possible other contact with hazardous materials associated with particular work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Pantex workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water

concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 3790.1B) ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at Pantex are expected to be substantially better than required by the standards.

**Health Effects Studies.** One mortality and one cancer incidence epidemiologic study on the general population in communities surrounding Pantex has been performed and one study of workers has been done. No significant excess cancer mortality was found and the analysis on excess cancer incidence had too few cases to be considered reliable. Workers were reported to show a non-statistically significant excess of brain cancer and leukemia in the one study conducted, but the small number of cases could be attributed to chance alone. For a more detailed description of the studies reviewed and the findings, refer to appendix section E.4.5.

**Accident History.** There have been no plutonium-dispersing detonation accidents during nuclear weapons operations at Pantex. In 1989, during a weapon disassembly and retirement operation, a release of deuterium-tritium in the assembly cell occurred. As a result, four workers received negligible doses and a fifth worker received a dose of approximately 2 rems. This was the first accidental release of radioactivity to occur at Pantex in 25 years.

In order to handle accidents, each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response to accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with planning, preparedness, and response. Section 4.1.9 provides a description of DOE's emergency preparedness program.

Pantex has an Emergency Management Plan with guidance on implementation provided by a series of Emergency Preparedness Procedures manuals to protect life and property within the facility, the health and welfare of surrounding areas, and the defense interests of the Nation during any credible emergency situation. Formal mutual assistance agreements have been made with the Amarillo Fire Department, the National Guard, and St. Anthony's Hospital. Under accident conditions, an emergency coordinating team of DOE and Pantex contractor management personnel would initiate the Pantex Emergency Plan and coordinate all onsite actions.

If offsite areas could be affected, the Texas Department of Public Safety would be notified immediately, and would make emergency announcements to the public and local governmental agencies in accordance with Annex R of the State of Texas Emergency Management Plan. Pantex has radiological assistance teams with a total of 46 personnel who are equipped and trained to respond to an accident involving radioactive contamination either onsite or offsite.

In addition, the Joint Nuclear Accident Coordination Center in Albuquerque, NM, can be called upon should the need arise. This would mobilize radiation emergency response teams from DOE, Department of Defense (DOD), and other participating Federal agencies (PX DOE 1983a).

#### 4.5.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for Pantex. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.4. Table 4.5.2.10–1 presents a summary of waste management activities at Pantex for 1992.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at Pantex. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

EPA Region 6 on July, 29, 1991, proposed Pantex for listing on the NPL of Superfund cleanup sites. Independent evaluations questioned this proposed listing and DOE dissented on the proposal. In September

**TABLE 4.5.2.10–1.—*Current Waste Management at Pantex Plant***

| Category | 1992 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Low-level** | | | | | | | |
| Liquid | 14 (3,300 gal) | Solidification | 14 (3,300 GPY) | Staged for processing | 113 (23,000 gal) | NA | NA |
| Solid | 220 | Compaction | 220 | Staged for shipment | Included in above | Shipped offsite to NTS | NA |
| **Mixed Low-Level** | | | | | | | |
| Liquid | 18 (3,600 gal) | None-onsite encapsulation pending | Planned | Staged for processing | 95 (19,000 gal) | NA | NA |
| Solid | 48 | Compaction and incineration | 1.6 | Staged for shipment | Included in above | Shipped offsite | NA |
| **Hazardous**[a] | | | | | | | |
| Liquid | 180 (36,100 gal) | Incineration[b] | Variable | Staged for shipment | 308[c] (62,000 gal) | Shipped offsite | NA |
| Solid | 720 | Incineration[b] | Variable | Staged for shipment | Included in above | Shipped offsite | NA |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 542,000[d] (109,309,000 gal) | Evaporation and filtration | 1,030,000 (207,000,000 GPY) | None | NA | Lagoon and NPDES outfall (stormwater) | 1,200,000 $yd^3$/yr (237,000,000 GPY) |
| Solid | 500[e] | Compaction and incineration | 270,000 | None | NA | Landfill (offsite) | NA |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | 54,400[f] (11,000,000 gal) | Carbon absorption/ filtration | Included in sanitary | None | NA | Included in sanitary | Included in sanitary |
| Solid | 8,500[g] | Compaction and incineration | Included in sanitary | None | NA | Landfill (onsite) – construction debris only | Expandable |

[a] Includes PCB and asbestos-contaminated wastes and some industrial wastewater.
[b] HE-contaminated wastes only.
[c] 135 $yd^3$ RCRA-permitted storage and 173 $yd^3$ for non-RCRA regulated storage.
[d] Sewage wastewater.
[e] May not include sewage sludge.
[f] Based on ratio of industrial wastewater to construction debris in 1991.
[g] Construction debris.
Note: NA - note applicable
Source: DOE 1993a; PX 1993a:1; PX Battelle 1992a; PX DOE 1994a; PX MH 1991c.

regarding the proposed listing. EPA placed Pantex on the NPL on May 31, 1994.

Pantex's waste management goals are to minimize the volumes of wastes it generates to the extent that is technologically and economically practicable, recycle those wastes applicable to the best available technology, minimize contamination of existing or proposed real property and facilities, minimize exposure and associated risk to human health and the environment to as low as reasonably achievable, and ensure safe and efficient long-term management of all wastes. Pantex manages the following waste categories: low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

**Spent Nuclear Fuel.** Pantex does not generate or manage spent nuclear fuel.

**High-Level Waste.** Pantex does not generate or manage HLW.

**Transuranic Waste.** Pantex does not generate or manage TRU waste as a result of normal operations. In the unlikely event that any TRU waste is generated, there are established provisions to manage this waste.

**Low-Level Waste.** LLW generated at Pantex consists of contaminated parts from weapons assembly and disassembly functions and radioactive waste materials associated with these functions, such as protective clothing, cleaning materials, filters, and other similar materials. As shown in table 4.5.2.10–1, Pantex generates a small quantity of liquid LLW. Liquid LLW is being stored onsite awaiting a planned solidification process. Compactible components are processed at Pantex's Solid Waste Compaction Facility and stored along with the noncompactible components for shipment to a DOE-approved disposal site and/or a commercial vendor. Pantex's LLW is presently shipped to NTS for disposal.

**Mixed Low-Level Waste.** Mixed LLW is generated during various component testing functions. These wastes consist primarily of small quantities of materials such as radioactively-contaminated solvents and wipes contaminated by organic solvents. Mixed LLW is currently stored onsite in RCRA-permitted facilities (PX Battelle 1992a:2-4). Pantex has received exemptions to DOE Order 5280.2A for mixed waste shipments to two RCRA-permitted commercial facilities. Pantex is currently developing its site treatment plan with the State of Texas and the EPA in order to provide mixed waste treatment capability for all mixed waste streams and to comply with the *Federal Facility Compliance Act* of 1992 and RCRA treatment, storage, and disposal requirements.

**Hazardous Waste.** Pantex received a RCRA Part B hazardous waste permit from the EPA and the Texas Natural Resources Conservation Commission on April 25, 1991. This permit authorizes Pantex to manage hazardous and industrial solid wastes listed in the permit. The permit also requires Pantex to notify the Texas Natural Resources Conservation Commission of the discovery of any release of hazardous waste or hazardous constituents that may have occurred from any solid waste management unit. The hazardous waste permit specifically excluded the 17 RCRA units at the high explosives burning ground that are currently operated under interim status with a written grant of authority from the Texas Natural Resources Conservation Commission. Pantex has submitted a request to the Texas Natural Resources Conservation Commission for a RCRA Part B permit modification to add these units at the Burning Ground. A decision on this modification has not been reached.

Most of the hazardous waste generated by Pantex results from HE operations; however, electroplating, photographic, and various other operations also generate additional hazardous waste streams. Liquid hazardous wastes, generally HE-contaminated wastewater, are filtered and settled to remove the majority of the HE and then treated at Pantex's wastewater treatment plant. This procedure is in compliance with the RCRA Administrative Order on Consent issued by EPA on September 7, 1989. The resulting solid HE-contaminated residue, along with other HE-contaminated solid hazardous waste (such as filters, cleaning materials, and protective clothing), HE scrap, and retired HE components are burned at Pantex's Burning Ground. Ash, debris, and residue resulting from this burning is transported offsite for approved disposal at a commercial RCRA-permitted facility (PX MH 1990b:2). All other

hazardous wastes generated at Pantex, including various chemicals, solvents, heavy metals, and other hazardous constituents, are manifested and shipped offsite by DOT-certified transporters for recycle or disposal at a commercial RCRA-permitted facility.

**Nonhazardous Waste.** Nonhazardous solid and liquid sanitary wastes are generated at Pantex. Sewage and some pretreated industrial wastewater is treated at the wastewater treatment plant. Liquid effluent from the plant flows into a lagoon, which then either evaporates or infiltrates into the ground. Liquid industrial waste is also treated in a tank system that removes metals from plating solutions and then neutralizes this solution. The effluent from this process is discharged to a playa, which is permitted by the Texas Natural Resources Conservation Commission. Stormwater discharges are regulated by a National Pollutant Discharge Elimination system permit (PX Battelle 1992a:1-4,5-1). When the wastewater treatment plant is upgraded, all industrial waste and sewage will be treated at that one location.

Nonhazardous solid waste generated onsite consists primarily of paper, cardboard, construction wastes, and cafeteria waste. Only construction wastes are disposed of onsite. Prior to late 1989, sanitary waste was disposed of at the onsite sanitary landfill. Since then, sanitary waste has been transported to the city of Amarillo landfill for disposal. Waste asbestos is sent to an offsite permitted landfill (PX MH 1991c:20).

### 4.5.3 Environmental Impacts

This section describes the environmental impacts of constructing and operating various tritium supply technologies and recycling facilities at Pantex which are described in sections 3.4.2 and 3.4.3. It begins by describing potential impacts to existing and planned facilities at Pantex, followed by descriptions of potential impacts and the environmental impacts of the proposed action on potentially affected environmental resources. The section concludes by describing the potential impacts of tritium supply and recycling on human health during normal operation, the consequences of facility accidents, and regulatory considerations and waste management. Each description addresses the effects of No Action and the potential impacts and environmental impacts of constructing and operating a tritium supply and collocated recycling facilities or a tritium supply facility alone at Pantex.

#### 4.5.3.1 *Land Resources*

Construction and operation of tritium supply and recycling facilities at Pantex would affect land resources, including land use and visual resources. As discussed in section 4.5.2.1, the proposed facilities could be located in any of three industrial sites. Potential land use impacts for each of these areas are discussed below. In general, each of these three areas contains sufficient land area to accommodate any of the proposed tritium supply technologies and recycling facilities (section 4.5.2.1). The proposed sites would meet and/or exceed a 1-mile buffer zone between plant operations and site boundary. The following sections describe effects of the proposed action on land resources.

**Land Use.**

*No Action.* Under No Action, DOE would continue existing and planned land use activities at Pantex. Any impacts to land use from these actions would be independent of, and unaffected by the proposed action.

*Tritium Supply and Recycling.* Any one of the tritium supply technologies and collocated recycling facilities (section 3.4) or a tritium supply facility alone, could be sited within one of the three designated areas located in the existing industrial core (figure 4.5.2.1–2). Table 4.5.3.1–1 shows the land area required for the tritium supply and recycling facilities. The land area affected ranges from 360 acres for the MHTGR to 173 acres for the APT. An additional 196 acres would be required if the tritium supply facility was collocated with a new recycling facility. As shown in the table, adequate land exists at each of the three designated areas. The only land use impact would be the displacement of existing agricultural uses on soils classified as prime farmland.

**TABLE 4.5.3.1–1.—*Potential Changes to Land Use Resulting from Tritium Supply Technologies and Recycling at Pantex Plant***

| | Tritium Supply Technologies and Recycling | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Indicator** | **HWR** | | | **MHTGR** | | | **ALWR[a]** | | | **APT[b]** | | | **Tritium Recycling** | | |
| Land requirements[c] (acres) | 260 | | | 360 | | | 350 | | | 173 | | | 196 | | |
| Industrial sites | A | B | C | A | B | C | A | B | C | A | B | C | A | B | C |
| Available land[d,e] (percent) | 45 | 34 | 29 | 62 | 47 | 40 | 60 | 46 | 39 | 30 | 23 | 19 | 34 | 26 | 22 |
| Total available land[f] (percent) | 1.9 | | | 2.6 | | | 2.5 | | | 1.2 | | | 1.4 | | |

[a] Land requirements for both Large and Small ALWR are the same.
[b] Land requirements for both Full and Phased APT are the same.
[c] Land area requirements are estimated to be the same for construction and operation.
[d] Industrial site A is 580 acres; Industrial site B is 760 acres; Industrial site C is 900 acres.
[e] Any land requirement less than 100 percent means sufficient land.
[f] Undeveloped land is approximately 14,000 acres.
Source: DOE 1994a; FDI 1993d; FDI 1994a; FDI 1994b; SNL 1993a; PX DOE 1991a.

No tritium facilities would be constructed offsite, and offsite land use would not be directly affected. Land is available within the region which could be converted to residential developments to house workers. Such development would be subject to city land use controls and zoning ordinances, which vary by city jurisdiction, and is unregulated in county jurisdictions.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced capacity to meet a tritium supply requirement less than baseline, or the construction and operation of a Phased APT would not change potential baseline tritium requirement land use impacts. Land requirements would be the same in both operation scenarios.

*Potential Mitigation Measures.* Facilities that are turned over to waste management outside the protected area could be totally removed so the land could be reclaimed for agricultural uses. New facilities could be designed to incorporate new technologies and be reduced in size.

**Visual Resources.**

*No Action.* Under No Action, the existing landscape characteristics would remain the same, consistent with VRM Class 4 (mixed use of industrial and open space) (figure 4.5.2.1–3).

*Tritium Supply and Recycling.* Construction and operation of any of the proposed tritium supply technologies and collocated recycling facilities or tritium supply alone would be consistent with the existing views that already include large industrial facilities. Of the tritium supply technologies, the APT would be much less visually obtrusive because of its low profile structures and cooling system (figure 3.4.2.4–1). The key viewpoint is located 1.5 miles southeast of Pantex at the intersection of Farm-to-Market Road 2377 and U.S. Route 60, which is designated a Texas Plains Trail and a scenic road. Pantex is noted as a point of interest. Tritium facilities in any of the three industrial areas would probably be visible from the key viewpoint. There would be no change to the VRM classification and no apparent change of the visual baseline from the key viewpoint.

*Less Than Baseline Operations.* Baseline visual impacts would not change due to operation of the HWR, MHTGR or ALWR at reduced capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Because no change in VRM classification is anticipated, no mitigation measures are proposed.

### 4.5.3.2 *Site Infrastructure*

This section discusses the site infrastructure for No Action and the modifications needed for actions due to construction and operation of new tritium supply and recycling facilities. With a new electrical substation, additional electrical transmission lines, and nominal increases to fuel procurement, the Pantex infrastructure would be capable of supporting any of the proposed technologies selected for the site. A comparison of site infrastructure and facilities resource needs for No Action and the proposed tritium supply alternatives is presented in table 4.5.3.2–1.

**No Action.** The missions discussed in section 3.3.5 would continue under No Action. It is anticipated that certain process improvements to be implemented in the near future would eliminate specific effluents and emissions and reduce or eliminate some waste streams. These process improvements would result in reduced utilities infrastructure requirements for Pantex. Estimated reductions are shown in table 4.5.3.2–1. No modifications are necessary under No Action. The existing site infrastructure would adequately support all No Action missions.

**Tritium Supply and Recycling.** The modifications to the infrastructure at Pantex to support the various tritium supply technologies and recycling facilities are summarized in table 4.5.3.2–1. For each technology under consideration, additional electrical energy and electrical load capability would be required to support the new site mission. Table 4.5.3.2–2 summarizes the demands the mission would place on the regional electrical power pool. The Electric Reliability Council of Texas and the West Central Power Pool would be able to meet the additional Pantex requirements for any of the tritium supply technologies. The alternatives would require between 0.47 and 4.28 percent of the regional power pool capacity margin. However, to make the additional energy and power available at Pantex within the required time frame, approximately 9 miles of electrical transmission lines

**TABLE 4.5.3.2–1.—*Modifications to Infrastructure for Tritium Supply Technologies and Recycling at Pantex Plant***

| | Transportation | | Electrical | | Fuel | | |
|---|---|---|---|---|---|---|---|
| **Alternative** | **Road (miles)** | **Railroad (miles)** | **Energy (MWh/yr)** | **Peak Load (MWe)** | **Oil (GPY)** | **Natural Gas (million ft$^3$/yr)** | **Coal (tons/yr)** |
| **Current Resources** | 47 | 17 | 77,000 | 13 | 274,000 | 520 | 0 |
| **No Action** | | | | | | | |
| Total site requirement | 47 | 17 | 70,000 | 12 | 260,000 | 470 | 0 |
| Change from current resources | 0 | 0 | -7,000 | -1 | -14,000 | -50 | 0 |
| **Heavy Water Reactor** | | | | | | | |
| Total site requirement | 47 | 17 | 698,000 | 97 | 392,000 | 717 | 0 |
| Change from current resources | 0 | 0 | 621,000 | 84 | 118,000 | 197 | 0 |
| **Modular High Temperature Gas-Cooled Reactor** | | | | | | | |
| Total site requirement | 47 | 17 | 518,000 | 74 | 391,000 | 483 | 0 |
| Change from current resources | 0 | 0 | 441,000 | 61 | 117,000 | -37 | 0 |
| **Large Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 47 | 17 | 1,258,000 | 168 | 510,000 | 477 | 0 |
| Change from current resources | 0 | 0 | 1,181,000 | 155 | 236,000 | -43 | 0 |
| **Small Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 47 | 17 | 738,000 | 103 | 420,000 | 477 | 0 |
| Change from current resources | 0 | 0 | 661,000 | 90 | 146,000 | -43 | 0 |
| **Full Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 47 | 17 | 3,898,000 | 578 | 323,200 | 477 | 0 |
| Change from current resources | 0 | 0 | 3,821,000 | 565 | 49,200 | -43 | 0 |
| **Phased Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 47 | 17 | 2,558,000 | 383 | 323,200 | 477 | 0 |
| Change from current resources | 0 | 0 | 2,481,000 | 370 | 49,200 | -43 | 0 |

Note: A negative number (-) indicates that sufficient resources exist to meet the demands.
Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; PX 1993a:2.

would need to be rerouted and connected to a new electrical substation. With this new substation, Pantex could accommodate anticipated electrical requirements for each of the technologies under consideration. Additional natural gas and fuel oil requirements could be satisfied through increased procurement through normal contractual means.

Coal requirements specified for the HWR are for providing steam energy. If the HWR was selected for Pantex, this requirement could be satisfied using the existing natural gas steam-producing facilities. No other modifications would be necessary.

**Tritium Supply Alone.** If new tritium recycling facilities were not collocated with the tritium supply

**TABLE 4.5.3.2–2.—*Impacts on Regional Electrical Power Pools from Tritium Supply Technologies and Recycling at Pantex Plant***

| Tritium Supply Technology and Recycling | Peak Power Required (MWe) | Capacity Margin (percent) | Annual Energy Required (MWh) | Total Electricity Production (percent) |
|---|---|---|---|---|
| Heavy Water Reactor | 85 | 0.64 | 628,000 | 0.16 |
| Modular High Temperature Gas-Cooled Reactor | 62 | 0.47 | 448,000 | 0.12 |
| Large Advanced Light Water Reactor | 156 | 1.18 | 1,188,000 | 0.31 |
| Small Advanced Light Water Reactor | 91 | 0.69 | 668,000 | 0.17 |
| Full Accelerator Production of Tritium | 566 | 4.28 | 3,828,000 | 0.99 |
| Phased Accelerator Production of Tritium | 371 | 2.80 | 2,488,000 | 0.65 |

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; NERC 1993a; SNL 1995a; PX 1993a:2.

facilities at Pantex, and the upgraded recycling facilities at SRS were utilized, the overall impact at Pantex would be reduced. Onsite transportation network and electrical transmission line requirements would not be affected. The electrical power requirements associated with each of the technologies would decrease by 88,000 MWh per year with the peak load decreasing by 16 MWe. This represents a reduction in the total site peak power requirement of between 3 and 22 percent with no appreciable change to the capacity margin of the regional power pool. Even with these reductions, additional power would still be required from the Electric Reliability Council of Texas and the West Central Power Pool but the impact would be marginally less than previously discussed. The natural gas requirement would decrease by 7 million $ft^3$ per year and the fuel oil requirement would decrease by 50,000 gallons per year. This represents a decrease in the overall site requirement of less than 2 percent for natural gas and from 10 to 15 percent for fuel oil.

**Less Than Baseline Operations.** In the event that only the steady state component of the baseline tritium requirement is required, the impacts on the site infrastructure for some supply technologies would change. There would be no appreciable change for the HWR, MHTGR, and ALWR technologies. The Phased APT would reduce electrical consumption by approximately 35 percent but the fuel, onsite transportation infrastructure, and power line requirements would not change.

**Potential Mitigation Measures.** The siting of new tritium supply and recycling facilities would require only minor modifications to the existing site infrastructure. Siting of electrical transmission lines could follow existing rights-of-way to minimize impacts to natural resources. Where new rights–of–way would need to be constructed, alignment would consider existing sensitive habitat (e.g., wetlands, prime farmland) to minimize the potential for impacts.

### 4.5.3.3 *Air Quality and Acoustics*

Construction and operation of a tritium supply and recycling facility at Pantex would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. To determine the impacts on air quality, criteria and toxic/hazardous concentrations from each technology have been compared with Federal and state standards and guidelines. Impacts for radiological airborne emissions are discussed in section 4.5.3.9.

In general, all of the proposed technologies would emit the same types of air pollutants during construction. Emissions would typically not exceed Federal, state, or local air quality regulations or guidelines, except that $PM_{10}$ concentrations may be close to or exceed the 24-hour standard during peak construction periods, which is not uncommon for large construction projects.

During operation, impacts from each of the individual tritium supply technologies and recycling facilities with respect to the concentrations of criteria and toxic/hazardous air pollutants are predicted to be in compliance with Federal, state, and local air quality regulations or guidelines. The estimated pollutant

concentrations presented in table 4.5.3.3–1 for each of the tritium supply technologies and recycling facilities indicate little difference between technologies with respect to impacts to air quality.

The Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on the emission rates presented in appendix table B.1.4–4, Prevention of Significant Deterioration permits may be required for each of the proposed alternatives at Pantex. This may require "offsets," reductions of existing emissions, to permit any additional or new emission source.

Noise emissions during either construction or operation are expected to be low. Air quality and acoustic impacts for each technology are described separately. Supporting data for the air quality and acoustics analysis, including modeling results, are presented in appendix B.

**Air Quality.** An analysis was conducted of the potential air quality impacts of emissions from each of the tritium supply technologies and recycling facilities. The air quality modeling analysis used the Industrial Source Complex Short-Term model recommended by EPA. The resulting air quality conditions were then evaluated against local, state, air quality regulations, and NAAQS (40 CFR 50). The potential exceedance of Prevention of Significant Deterioration (40 CFR 52.21) increments for $PM_{10}$, $SO_2$, or $NO_2$ was also determined.

*No Action.* No Action utilizes estimated air emissions data from operations at Pantex in the year 2010 assuming continuation of site missions as described in section 3.3.4. These data reflect conservative estimates of criteria and toxic/hazardous emissions at Pantex. The emission rates for the criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.1.4–4. Table 4.5.3.3–1 presents the No Action concentrations. Pollutant concentrations are in compliance with all air quality regulations and guidelines except the 30-minute hydrogen chloride standard. It is conservatively assumed that $PM_{10}$ concentrations are equal to TSP concentrations. Emissions of hydrogen chloride result from the open air burning of explosives. The proposed waste explosives treatment/disposal facility should reduce the emissions of hydrogen chloride such that the resulting concentrations are in compliance with the regulations.

*Tritium Supply and Recycling.* Alternatives for Pantex consist of four candidate technologies: HWR, MHTGR, ALWR, and APT, alone or collocated with tritium recycling facilities. Air pollutants would be emitted during construction of the tritium supply and recycling facilities. The principal sources of such emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant.

- Exhaust from, and road dust raised by, construction equipment, vehicles delivering construction material, and vehicles carrying construction workers.

$PM_{10}$ concentrations are expected to be close to or exceed the 24-hour ambient standard during the peak construction period. Exceedances would be expected to occur during dry and windy conditions. Appropriate control measures would be followed, such as watering to reduce emissions. With the exception of $PM_{10}$, it is expected that concentrations of all other pollutants at the Pantex boundary would remain within applicable Federal and state ambient air quality standards.

Air pollutant emission sources associated with the operation of each of the technologies include all or part of the following:

- Increased operation of existing boilers to generate additional steam for space heating.

- Operation of diesel generators and periodic testing of emergency diesel generators.

- Recycling operations.

- Exhaust from, and road dust raised by, vehicles delivering supplies and bringing employees to work.

TABLE 4.5.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Pantex Plant* [Page 1 of 4]

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Recycling: HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling[a] (μg/m³) |
|---|---|---|---|---|---|---|---|---|
| **Criteria Pollutant** | | | | | | | | |
| Carbon monoxide (CO) | 8-hour | 10,000 | 1,352 | 1,374 | 1,427 | 1,380 | 1,361 | 9 |
| | 1-hour | 40,000 | 7,836 | 7,964 | 8,269 | 7,997 | 7,886 | 50 |
| Lead (Pb) | Calendar Quarter | 1.5 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | [b] |
| Nitrogen dioxide ($NO_2$) | Annual | 100 | 2 | 2 | 3 | 3 | 2 | 0.2 |
| Ozone ($O_3$) | 1-hour | 235 | [b] | [b] | [b] | [b] | [b] | [b] |
| Particulate matter ($PM_{10}$) | Annual | 50 | 27 | 27 | 27 | 27 | 27 | 0.04 |
| | 24-hour | 150 | 114 | 116 | 115 | 116 | 115 | 0.9 |
| Sulfur dioxide ($SO_2$) | Annual | 80 | 0.03 | 0.04 | 0.04 | 0.05 | 0.03 | <0.01 |
| | 24-hour | 365 | 24 | 25 | 25 | 25 | 24 | 0.1 |
| | 3-hour | 1,300 | 194 | 196 | 196 | 198 | 195 | 0.6 |
| **Mandated by Texas** | | | | | | | | |
| Hydrogen fluoride | 30-day | 0.8 | [c] | [c] | [c] | [c] | [c] | [b] |
| | 7-day | 1.6 | [c] | [c] | [c] | [c] | [c] | [b] |
| | 24-hour | 2.9 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | [b] |
| | 12-hour | 3.7 | [c] | [c] | [c] | [c] | [c] | [b] |
| **Hazardous and Other Toxic Compounds** | | | | | | | | |
| Acetone | 30-minute[d] | 5,900 | 341.1 | 341.1 | 341.1 | 363.3 | 341.1 | [b] |
| | Annual | 590 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | [b] |
| Acetylene | 30-minute[d] | 26,620 | [b] | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| | Annual | 2,660 | [b] | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Aliphatic hydrocarbons | 30-minute[d] | [e] | 19 | 19 | 19 | 19 | 19 | [b] |
| | Annual | [e] | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Ammonia | 30-minute[d] | 170 | [b] | [b] | [b] | 11.7 | [b] | [b] |
| | Annual | 17 | [b] | [b] | [b] | 0.03 | [b] | [b] |
| Aromatic hydrocarbons | 30-minute[d] | [e] | 27.2 | 27.2 | 27.2 | 27.2 | 27.2 | [b] |
| | Annual | [e] | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |

**TABLE 4.5.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Pantex Plant* [Page 2 of 4]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Recycling: HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling[a] (μg/m³) |
|---|---|---|---|---|---|---|---|---|
| **Hazardous and Other Toxic Compounds** (continued) | | | | | | | | |
| Aromatic petroleum distillate | 30-minute[d] | 3,500 | 13.6 | 13.6 | 13.6 | 13.6 | 13.6 | [b] |
| | Annual | 350 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| 2-Butoxyethanol | 30-minute[d] | 1,210 | 208.9 | 208.9 | 208.9 | 208.9 | 208.9 | [b] |
| | Annual | 121 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | [b] |
| Butyl acetate | 30-minute[d] | 1,850 | 87 | 87 | 87 | 87 | 87 | [b] |
| | Annual | 710 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | [b] |
| Butyl alcohol | 30-minute[d] | 1,220 | 31.6 | 31.6 | 31.6 | 31.6 | 31.6 | [b] |
| | Annual | 150 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | [b] |
| Chlorodifluoromethane | 30-minute[d] | 18,000 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | [b] |
| | Annual | 1,800 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Cyanogen | 30-minute[d] | 210 | 161.8 | 161.8 | 161.8 | 161.8 | 161.8 | [b] |
| | Annual | 21 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | [b] |
| Cyclohexane | 30-minute[d] | 1,435 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | [b] |
| | Annual | 340 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Dichlorodifluoromethane | 30-minute[d] | 49,500 | 23.3 | 23.3 | 23.3 | 23.3 | 23.3 | [b] |
| | Annual | 4,950 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Diesel fuel | 30-minute[d] | 90 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | [b] |
| | Annual | 9 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Epoxy solvent | 30-minute[d] | [e] | 16.5 | 16.5 | 16.5 | 16.5 | 16.5 | [b] |
| | Annual | [e] | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Ethyl alcohol | 30-minute[d] | 18,800 | 12.2 | 14.8 | 14.8 | 14.8 | 14.8 | 2.6 |
| | Annual | 1,880 | <0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Freon TF | 30-minute[d] | [e] | 24.8 | 24.8 | 24.8 | 24.8 | 24.8 | [b] |
| | Annual | [e] | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | [b] |
| Hydrocarbons | 30-minute[d] | [e] | 1,812 | 1,812 | 1,812 | 1,812 | 1,812 | [b] |
| | Annual | [e] | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | [b] |

TABLE 4.5.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Pantex Plant* [Page 3 of 4]

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling[a] (μg/m³) |
| **Hazardous and Other Toxic Compounds** (continued) | | | | | | | | |
| Hydrogen chloride | 30-minute[d] | 75 | 232.3 | 232.3 | 232.3 | 232.3 | 232.3 | [b] |
| | Annual | 0.1 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | [b] |
| Isopropyl alcohol | 30-minute[d] | 7,856 | 127.3 | 127.3 | 127.3 | 127.3 | 127.3 | [b] |
| | Annual | 980 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | [b] |
| Methane | 30-minute[d] | [e] | [b] | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| | Annual | [e] | [b] | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Methyl alcohol | 30-minute[d] | 2,620 | 178.3 | 181.0 | 181.0 | 181.0 | 181.0 | 2.6 |
| | Annual | 262 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 | 0.01 |
| Methyl ethyl ketone | 30-minute[d] | 3,900 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | [b] |
| | Annual | 590 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | [b] |
| Methyl isobutyl ketone | 30-minute[d] | 2,050 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | [b] |
| | Annual | 205 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Nitric acid | 30-minute[d] | 52 | [b] | 13.3 | [b] | 155.3 | [b] | [b] |
| | Annual | 5.2 | [b] | 0.03 | <0.01 | 0.41 | [b] | [b] |
| Tetrahydrofuran | 30-minute[d] | 5,900 | 29.6 | 29.6 | 29.6 | 29.6 | 29.6 | [b] |
| | Annual | 590 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | [b] |
| Toluene | 30-minute[d] | 3,750 | 236.2 | 236.2 | 236.2 | 236.2 | 236.2 | [b] |
| | Annual | 375 | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 | [b] |
| 1,1,1-Trichloroethane | 30-minute[d] | 19,100 | 8.3 | 10.5 | 9.0 | 59.3 | 8.3 | [b] |
| | Annual | 1,910 | <0.01 | 0.01 | <0.01 | 0.14 | <0.01 | [b] |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane | 30-minute[d] | 76,000 | 12.6 | 12.6 | 12.6 | 12.6 | 12.6 | [b] |
| | Annual | 7,600 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Trichlorotrifluoroethane | 30-minute[d] | 10,000 | 7.3 | 101.6 | 7.3 | 7.3 | 7.3 | [b] |
| | Annual | 1,000 | <0.01 | 0.25 | <0.01 | <0.01 | <0.01 | [b] |

**TABLE 4.5.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Recycling Including No Action at Pantex Plant* [Page 4 of 4]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling[a] (μg/m³) |
| **Hazardous and Other Toxic Compounds** (continued) | | | | | | | | |
| VM&P naphtha | 30-minute[d] | 3,500 | 23.3 | 23.3 | 23.3 | 23.3 | 23.3 | [b] |
| | Annual | 350 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |
| Xylene | 30-minute[d] | 3,700 | 44.2 | 44.2 | 44.2 | 44.2 | 44.2 | [b] |
| | Annual | 435 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | [b] |

[a] Concentrations for tritium supply and recycling include 2010 No Action concentrations. To determine the concentrations of pollutants from each tritium supply technology, subtract the pollutant concentration for tritium recycling from each of the tritium supply and recycling concentrations.

[b] No sources indicated.

[c] Data unavailable.

[d] 1-hour predicted concentrations were used for 30-minute standard.

[e] There is no standard.

Note: DOE is committed to the phaseout of ozone-depleting substances and will discontinue use of these substances according to EPA phaseout schedules.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX 1992a:10; PX 1993a:2; PX ACB 1987a; PX ACB 1991a.

Appendix table B.1.4–4, presents emissions from each of the proposed tritium supply technologies and recycling facilities. There are no gaseous releases associated with the APT (SNL 1995a), although emissions are associated with operation of the tritium supply facility included with the APT and with recycling facilities. Emissions from the Large ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Consequences from operation of each of the tritium supply and recycling facilities at Pantex are presented in table 4.5.3.3–1. Pollutant concentrations, combined with the No Action concentrations, are in compliance with Federal and state standards except for the 30-minute standard for hydrogen chloride.

Pollutant emissions resulting from the operation of tritium supply technologies alone (HWR, MHTGR, ALWR, and APT) consist of criteria pollutants from the operation of boilers and diesel generators and toxic/hazardous pollutant emissions from facility processes. Criteria pollutant emissions from the MHTGR are the highest among the other tritium supply technologies and would increase existing total site criteria pollutant emissions by greater than 100 percent above No Action emissions. Concentrations of criteria and toxic/hazardous pollutants, added to No Action concentrations, are in compliance with Federal and state standards except the 30-minute hydrogen chloride standard.

*Less Than Baseline Operations.* Air emissions from the HWR would be reduced slightly when operated at reduced capacity. However, the reduction would be negligible because most emissions are attributed to support equipment and facilities that are not related to the reactor operating level. The MHTGR or ALWR would have no change in air emissions because it would continue to operate at the same level as the baseline requirement to maintain power levels for steam or electric production. The Phased APT construction and operation emissions and impacts would be the same as the Full APT.

*Potential Mitigation Measures.* Potential mitigation measures during construction include: watering to reduce dust emissions; applying nontoxic soil stabilizers to all inactive construction areas; cover, water or apply nontoxic soil binders to exposed piles (i.e., gravel, sand, dirt); suspend all excavation and grading operations when wind speeds warrant; pave construction roads that have a traffic volume of more than 50 daily trips by construction equipment; use electricity from power poles rather than temporary gasoline and diesel power generators. Potential mitigation measures during operation include incorporating additional HEPA filters to reduce particulate emissions from processing facilities; substituting cleaning solvents for those which present health hazards or exceed the applicable standards; and switching from coal or fuel oil to natural gas to reduce criteria pollutants.

**Acoustics.** The location of the tritium supply technologies and recycling facilities relative to the site boundary and sensitive receptors were examined to determine the potential for onsite and offsite impacts.

*No Action.* The continuation of operations at Pantex would result in no appreciable change in traffic noise and onsite operational noise sources from current levels (section 4.5.2.3). Sources of nontraffic noise associated with operations are located at sufficient distances from offsite noise-sensitive receptors that the contribution to offsite noise levels would continue to be small.

*Tritium Supply and Recycling.* Noise sources during construction may include heavy-construction equipment and increased traffic. Increased traffic would occur onsite and along major offsite transportation routes used to bring construction material and workers to the site.

Most nontraffic noise sources associated with operation of any tritium supply, technologies, and recycling facilities would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would continue to be small. Due to the size of the site, noise emissions from construction and operation activities would not be expected to cause annoyance to the public.

Noise impacts associated with increased traffic on access routes would be considered in tiered NEPA documents. Some nontraffic noise sources associated with construction and operation of the tritium supply technologies and recycling facilities, may be located close enough to offsite noise receptors that they could experience some increase in noise levels.

*Less Than Baseline Operations.* Baseline noise impacts would not change due to reactors operating at reduced capacity or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Potential measures to minimize noise impacts on workers include the use of standard silencing packages on construction equipment and providing workers in noisy environments with appropriate hearing protection devices meeting OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

#### 4.5.3.4 *Water Resources*

Environmental impacts associated with the construction and operation of the proposed tritium supply technologies and recycling facilities at Pantex would affect surface water and groundwater resources. All water required for construction or operation would be supplied from groundwater. The Ogallala aquifer will be used to accommodate water requirements at Pantex which has been projected to be adequate up to the year 2040 by the Texas Natural Resources Conservation Commission. The proposed sites for the tritium supply and recycling facilities would be outside the 100-year floodplain. Information on the location of the 500-year floodplain at Pantex is currently not available. During construction, treated sanitary wastewater would be discharged to playa lakes. Although the potential impacts to surface waters during the construction phase for any of the proposed facilities would be erosion of disturbed land and sedimentation in drainage channels, the relatively dry climate and application of appropriate management measures should preclude adverse impacts. All wastewater would be treated and either recycled for cooling system makeup or released to playa lakes. No wastewater would be discharged to surface waters during operation of tritium facilities; therefore, no impacts to surface water quality are expected. Stormwater runoff would be collected and treated if necessary before discharge to natural drainage channels.

Table 4.5.3.4–1 presents existing surface water and groundwater resources and the potential changes to water resources at Pantex resulting from the proposed tritium supply and recycling facilities. Resource requirements for each tritium supply technology shown in this table represent the total requirements at the site, including No Action. Resource requirements for tritium recycling are added to these values to obtain the water resource requirements for assessing impacts associated with combined tritium supply and recycling.

**Surface Water.**

*No Action.* Under No Action, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities which are independent of and unaffected by the proposed action. A description of the activities that would continue at Pantex is provided in section 3.3.5. No demands on surface water supplies would occur; however, wastewater discharges to Playas 1, 2, and, possibly 4, would continue.

*Tritium Supply and Recycling.* There are no unique construction characteristics associated with water requirements and discharges among any of the candidate technologies. No surface water would be withdrawn for any construction or operation activities associated with any of the tritium supply technologies whether collocated with recycling facilities or sited alone. Consequently, it is not anticipated that there would be any impacts to surface water availability or surface water quality. Nonhazardous wastewater generated during construction and operation of the tritium facilities would either be recycled or treated and released to the playa lakes. The potential impacts to surface waters during the construction phase for any of the tritium supply technologies would be erosion of disturbed land and sedimentation in drainage channels. The potential for erosion would be greatest for the construction of the MHTGR (table 4.5.3.1–1). To minimize impacts of soil erosion, standard construction stormwater management and erosion control measures would be employed. The dry climate and application of appropriate management measures should preclude adverse impacts from stormwater runoff. It is anticipated that impacts from runoff would be temporary and manageable. Nonhazardous wastewater, including sanitary wastewater, generated during the construction of either the collocated tritium supply technologies and recycling facilities (which ranges from 1.2 MGY for the APT to 28.4 MGY for the Large ALWR) or the tritium supply facilities alone (which ranges from 0.3 MGY for the APT to 27.5

**TABLE 4.5.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Pantex Plant***

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | Tritium Recycling[b] |
| | | | | Large | Small | Full | Phased | |
| **Construction** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total water requirement (MGY)[c] | 286 | 307 | 304 | 319 | 306 | 294 | 294 | 1.5 |
| Percent increase in projected water use (286 MGY) | 0 | 7 | 6 | 12 | 7 | 3 | 3 | NA |
| Percent of county project pumpage (22,306 MGY) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to playas (MGY)[d] | 183 | 199 | 196 | 210 | 198 | 183 | 183 | 0.9 |
| Percent change in flow of wastewater to playas | 0 | 9 | 7 | 15 | 8 | <1 | <1 | NA |
| NPDES permit required[e] | NA | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| **Operation** | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total water requirement (MGY)[f] | 286 | 334 | 316 | 376 | 336 | 2,928 | 1,977 | 14 |
| Percent increase in projected water use (286 MGY) | 0 | 17 | 10 | 31 | 17 | 924 | 591 | - NA |
| Percent of county project pumpage (22,306 MGY) | 1.3 | 2 | 1 | 2 | 2 | 13 | 9 | NA |
| ***Water Quality*** | | | | | | | | |
| Wastewater discharge to playas (MGY) | 183 | 231 | 213 | 273 | 233 | 183 | 183 | 5 |
| Percent change in flow of wastewater to playas | NA | 26 | 16 | 49 | 27 | 0 | 0 | NA |
| NPDES permit required[d] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| **Floodplain** | | | | | | | | |
| Actions in 100-year floodplain | NA | No | No | No | No | No | –No | NA |
| Critical actions in 500-year floodplain | NA | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | NA |
| Floodplain assessment required | NA | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | NA |

[a] Operational water requirements for MHTGR and ALWR include utilization of stream generators.

[b] Resource requirements for tritium recycling do not include No Action. The values presented in this column are added to the requirements of each tritium supply technology to assess the impacts associated with combined tritium supply and recycling.

[c] Total water requirements for construction at Pantex are calculated by adding baseline requirements (286 MGY) with that for each tritium supply: HWR (21.3 MGY), MHTGR (17.8 MGY), ALWR (33.3 MGY for Large and 20 MGY for Small), and APT (8.3 MGY).

[d] The total wastewater discharged to playas for construction and operation is the sum of the tritium facilities wastewater generation rate and the projected discharge rate (182.85 MGY).

[e] All discharges to natural drainages require NPDES permits.

[f] Total water requirements for operation at Pantex are calculated by adding baseline requirements (286 MGY) with that for each tritium technology: HWR (48 MGY), MHTGR (30 MGY), APT (1,691 MGY for Phased and 2,642 MGY for Full), and ALWR (90 MGY for Large and 50 MGY for Small).

Note: NA - Not Applicable

Note: Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX 1993a:2; SR DOE 1995a.

MGY for the Large ALWR) would be discharged to playas. Discharge of wastewater generated during construction of these facilities to playas would not result in an exceedance of the Texas Natural Resources Conservation Commission-permitted limit of 1.05 MGD.

During operation, utility, process, and sanitary wastewater for the HWR, MHTGR, and ALWR would be treated prior to discharge into the playas. However, cooling system blowdown and sanitary wastewater for the APT would be treated and recycled for reuse as cooling system makeup. The treated effluent from the process wastewater treatment would be discharged to playas. Treated effluent would be monitored to comply with the NPDES permit and other discharge requirements. The extent to which treated effluent or stormwater would be recycled for reuse within the plant would be determined during site-specific studies.

An analysis of wastewater discharged to the playas indicated that the volume of the release would be within the Texas Natural Resources Conservation Commission-permitted limit of 1.05 MGD. Stormwater runoff from either the collocated tritium supply and recycling facilities or the tritium supply alone would be collected in detention ponds. Runoff from site support facilities outside the main plant, except those that require onsite management measures by regulation such as sanitary wastewater plants and landfill areas, would be discharged directly to natural drainage channels. Uncontaminated stormwater runoff would be released to natural drainage channels, while contaminated runoff would be retained, treated in the radioactive waste treatment system, and released. All discharges to playas would be monitored and subject to NPDES permit requirements.

No construction activities would take place in areas delineated as 100-year floodplains. However, there is no information on the location of the 500-year floodplain at Pantex. Because operation of the tritium supply facility may constitute a critical action, an assessment of the 500-year floodplain should be made before construction activities can be initiated. This study would be conducted in site-specific tiered NEPA documents.

*Less Than Baseline Operations.* Baseline surface water impacts described above for the construction and operation phases would not change due to changes in reactor operating capacity, or construction and operation of a Phased APT.

*Potential Mitigation Measures.* Because appropriate erosion and runoff management measures would be implemented during construction to comply with NPDES stormwater management regulations, no additional mitigation measures should be necessary. Stormwater measures include erosion control measures such as silt fences, dikes, and sediment traps to divert runoff away from disturbed areas and stabilization practices that cover soils with materials such as rip rap, or mulch in order to prevent direct exposure of soils to runoff.

**Groundwater.**

*No Action.* Under No Action, baseline conditions and operations, described in section 3.3.5, would continue at the plant, and current groundwater usage of 257 MGY would increase to 286 MGY by the year 2005. Groundwater used would continue to be withdrawn from the Ogallala aquifer through wells located on the Pantex property. No additional impacts to groundwater quality are anticipated since there are no direct discharges to groundwater.

**Groundwater Availability and Use.**

*Tritium Supply and Recycling.* Construction water requirements for either the collocated tritium supply and recycling facilities or the tritium supply alone are small relative to total water in aquifer storage, but still represent an amount greater than the annual recharge for the area. As shown in table 4.5.3.4–1, construction of either a Large ALWR with recycling (321 MGY) or a Large ALWR alone (319 MGY) would represent approximately a 12-percent maximum increase over the projected groundwater usage and would increase the total projected amount to be pumped in Carson County by approximately 1 percent. During construction, none of these facilities would cause more than a 5-inch drawdown.

Groundwater required for both construction and operation and the percent increase in projected water use for each technology are shown in table 4.5.3.4–1. Previous studies have shown that when the Amarillo

City Well Field pumped 4,900 MGY from the Ogallala aquifer, an average of 6-foot-per-year decline in the water table occurred over a 10-year period in the local well field area. The aquifer water level decline caused a shift in the groundwater flow direction beneath Pantex. Operating an HWR, MHTGR, or ALWR, collocated with recycling or alone, would result in less than a 1-foot drawdown but would exacerbate the existing adverse groundwater impacts. Operating a Full APT with tritium recycling at 3/8 capacity would require the highest groundwater withdrawal (2,656 MGY) and result in an approximately 3 feet of additional drawdown per year. However, the more likely operating scenario for the APT would be to operate at 3/8 level for five years (requiring groundwater withdrawals of 2,656 MGY), operating at 3/16 capacity for 30 years (requiring 1,705 MGY), and not operating for five years. Over the 40-year operating period, the average withdrawal would be 1,611 MGY. The additional drawdown would be approximately 1.5 feet per year. Additional water wells would be required, and the increased groundwater withdrawal would cumulatively add to the existing adverse impacts on the Ogallala aquifer for both operating scenarios. Long-term implications would need to be determined by trend analysis in site-specific tiered NEPA documents. An undeveloped area of 1,080 acres at Pantex Lake has been retained by Pantex as a potential area for drilling additional water wells to support such operational requirements if needed.

*Less Than Baseline Operations.* Operation of the HWR at reduced capacity to meet a tritium supply requirement less than baseline would not change the operation water requirements or the quantity of water discharges. The MHTGR or ALWR water requirements and discharges would not change from the baseline; therefore, the potential impacts would remain the same.

Operation of the Phased APT would require 1,977 MGY, a 591-percent increase over projected No Action water use (see Table 4.5.3.4–1). This is approximately two thirds of the 924-percent increase required by the Full APT and 9 percent of the projected pumping requirements of Carson County. In order to meet this water requirement the new well field that would be required for the Full APT would also be required for the Phased APT. However, the well field could contain less wells or pump at a lower rate to supply the Phased APT, resulting in smaller drawdowns. All other requirements of the Phased APT are identical to those of the Full APT.

**Groundwater Quality.**

*Tritium Supply and Recycling.* As discussed in the surface water section, construction and operation of the tritium facilities would not result in direct discharges to groundwater. However, treated wastewater discharged to playas could percolate into the groundwater. All contaminants that have entered the aquifer are expected to move downgradient to the north, away from existing facilities. Withdrawal from the aquifer would have little effect on plume migration.

*Less Than Baseline Operations.* Potential groundwater quality impacts described above would not change due to changes in reactor operating capacities, or the construction and operation of a Phased APT.

*Potential Mitigation Measures.* Impacts from groundwater withdrawal may require mitigation. During design, obtaining water from other sources in the region should be considered. Other mitigation measures may include any of the following: redesigning the facilities so they are more water efficient, investigating ways to recharge the aquifer, and limiting production hours. Mitigation measures to reduce wastewater seepage could include building lined evaporation ponds.

### 4.5.3.5 *Geology and Soils*

Construction of tritium facilities at Pantex would have no impact on geological resources described in section 4.5.2.5. Hazards posed by geological conditions are negligible at Pantex. Construction would disturb up to a few hundred surface acres of soil, the amount depending on the tritium supply technology and recycling facilities. Control measures would be used to minimize soil erosion. Impacts would depend on the specific soil units in the disturbed area, the extent of land disturbing activities, and the amount of soil disturbed. Potential changes to geology and soils associated with the construction and operation of the tritium supply and recycling facilities at Pantex are discussed below.

*No Action.* Under No Action DOE would continue existing and planned activities at Pantex. Any impacts to geology and soils from these actions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Construction activities would not affect geological conditions. Design of the facilities would ensure that they would not be adversely affected by geologic conditions.

There are no known capable faults within the boundaries of Pantex. Therefore, there is little chance for ground rupture as a result of an earthquake. Minor ground shaking is somewhat more likely but is not anticipated during the life of the project. Intensities of more than IV on the modified Mercalli scale are not likely at Pantex. Ground shaking could affect the integrity of poorly designed or nonreinforced structures but would not affect newly designed facilities. Based on the seismic history of the area, a very low seismic risk exists at Pantex and should not preclude safe construction and operation of a tritium supply and collocated recycling facilities or tritium supply alone. In addition, all facilities would be designed for earthquake-generated ground acceleration in accordance with DOE Order 5480.28 and accompanying safety guides.

Volcanic activity has not occurred in the area for millions of years and is extremely unlikely to impact the project. It is also highly unlikely that landslides, sinkhole development, or other nontectonic events would affect project activities. Slopes and underlying foundation materials are stable. Potential health impacts from accidents associated with geological hazards are discussed in section 4.5.3.9.

Properties and conditions of soils underlying the proposed sites have no limitations on construction with the exception of a moderate-to-severe shrink-swell potential in nearly all areas. This factor would be considered in facility design and site preparation. Soils would be impacted during construction of any of the facilities. The amount of acreage that would be potentially disturbed by the tritium supply technologies and tritium recycling facilities is shown in table 4.5.3.1–1. Soils therefore would not adversely affect the safe operation of project activities.

The surface area of soil disturbance from construction of new facilities would be as much as 562 acres for a MHTGR collocated with recycling facilities. Disturbance would occur at building, parking, and construction laydown areas, destroying the soil profile and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and, particularly during the construction period, the duration of time the soil is bare. Construction of both the MHTGR and the APT would also necessitate deep excavations to accommodate reactor modules and an accelerator tunnel, respectively (sections 3.4.2.2 and 3.4.2.4). A considerable volume of soil would be removed as a result of excavations. Most of the material removed would be sand or shale fragments derived from bedrock and could be stockpiled for use as fill. Some of this material could be used to cover the accelerator tunnel of the APT. Site-specific NEPA studies would evaluate in detail impacts to geology and soils at Pantex resulting from deep excavations required for the MHTGR and the APT and would identify appropriate mitigation measures.

Net soil disturbance during operations would be less than for construction, because areas temporarily used for laydown would be restored. Although erosion from stormwater runoff and wind action could occur occasionally during operations, they are anticipated to be minimal.

Appropriate erosion and sediment control measures would be used to minimize soil loss. Wind erosion is likely to occur on an intermittent basis, depending on the wind velocities, the amount of soil exposed, and the effectiveness of control measures.

*Less Than Baseline Operations.* Under the less than baseline tritium requirement operation, geological and soil impacts would not change for the HWR, MHTGR or ALWR technologies. Disturbed acreage for the Phased APT would be the same as the baseline tritium requirement case Full APT, therefore impacts would be the same.

*Potential Mitigation Measures.* Mitigation measures would be required to control erosion of soil,

especially during construction. Potential mitigation measures include standard practices for erosion, sediment, and dust control such as silt fences, sediment traps, runoff diversion dikes, drainageways, sedimentation ponds, establishment of ground cover and windbreaks, grading of slopes, and construction of berms or other controls appropriate to the sites. Standard control for wind erosion, such as wetting the surface, would be done on a day-to-day basis. Exposing only small areas for limited periods of time, as necessary, could also reduce erosional effects. After the construction period, long-term control measures could include grading, revegetation, or landscaping.

#### 4.5.3.6 *Biotic Resources*

Construction and operation of tritium supply and recycling facilities at Pantex would have the potential to affect biotic resources. Impacts resulting from the construction of the HWR, MHTGR, ALWR, or Full APT to meet the baseline tritium requirement would occur only at the beginning of the project life cycle. The less than baseline tritium requirement, Phased APT could incur some additional construction-related impacts if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion would occur in the already developed main plant site. Impacts to terrestrial resources would result from the loss of habitat during construction and operation. Wastewater discharge to the playas could cause a general degradation of the naturally occurring ephemeral wetland system at Pantex and an increase in open water habitat. The only consistently occurring Federally-listed threatened or endangered species that would potentially be disturbed by the proposed action are wintering bald eagles that forage at playas. Several special-status species could be affected, primarily through the loss of potential foraging, denning, and nesting habitat or by the destruction of less mobile species during construction. Where impacts could occur, mitigation measures would be developed in consultation with the USFWS. This consultation would be conducted at the site-specific level in tiered NEPA documents. Table 4.5.3.6–1 summarizes the potential changes to biotic resources at Pantex resulting from the proposed action. In general, no major difference in impacts to biotic resources exists among the four tritium supply technologies and recycling facilities.

**Terrestrial Resources.**

*No Action.* Under No Action, the mission described in section 3.3.4 would continue. This would result in no additional impacts to terrestrial resources. Vegetation bordering playas would remain and those portions of the site currently used for agricultural purposes would be maintained. These areas would continue to provide the same amount of wildlife habitat as in the past.

*Tritium Supply and Recycling.* Construction and operation of the HWR, MHTGR, ALWR, or APT and recycling facilities at the proposed TSS would result in the disturbance of 462, 562, 552, and 375 acres, respectively, or between 2.5 and 3.7 percent of the site (table 4.5.3.6–1). The acreage includes areas on which plant facilities would be constructed, as well as areas revegetated following construction. Vegetation within the proposed TSS would be lost during land clearing activities. Since development would not occur on playas, new construction would take place on open land, agricultural land, or previously developed areas.

Constructing any of the tritium supply technologies and recycling facilities would have some adverse effects on animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would be destroyed during land clearing activities. Construction activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. The long-term survival of these animals would depend on whether the area to which they moved was at or below its carrying capacity. Nests of migratory birds and young animals living within the proposed TSS could be lost during construction. Areas that would be re-established as farmland or revegetated upon completion of construction would be recolonized by animal species present in nearby, undisturbed habitats.

Activities associated with facility operation, such as noise and human presence, could affect wildlife living immediately adjacent to the facility. These disturbances may cause some species to move from the area.

A nonevaporative cooling design is proposed for all tritium supply technologies at Pantex except for the APT. While there would be no impacts to vegetation

**TABLE 4.5.3.6–1.—*Potential Impacts to Biotic Resources During Construction and Operation Resulting from Tritium Supply Technologies and Recycling at Pantex Plant***

| Affected Resource Indicator | No Action | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | Tritium Recycling |
| Acres of habitat disturbed | 0 | 462[a] | 562[a] | 552[a] | 375[a] | 202 |
| Wetlands potentially impacted | None | Yes | Yes | Yes | Yes | Yes |
| Aquatic resources potentially impacted | None | None | None | None | None | None |
| Number of threatened and endangered species potentially affected[b] | 0/0 | 1/6 | 1/6 | 1/6 | 1/6 | 1/6 |

[a] Acreage disturbed by each tritium supply technology may be obtained by subtracting the acreage for the tritium recycling facility from the tritium supply technologies and recycling acreage.

[b] The number of threatened and endangered species are represented by two data inputs (a/b) where: a = the number of Federal-listed threatened and endangered species, and b = the number of all other special status species (i.e., Federal candidate and/or state-listed species) that are potentially impacted.

Source: DOE 1992b; DOE 1992o:1; FDI 1993a; FDI 1993c.

from salt drift from an HWR, MHTGR, or ALWR, this may not be the case for the APT. A total of 10 separate cooling towers would be located along the length of the facility (section 3.4.2.4). Since design parameters for these towers are not known at this time, it is not possible to estimate impacts. This would be determined in future tiered NEPA documentation.

Construction and operation of a tritium supply facility alone would result in similar impacts to terrestrial resources but less than those described for a collocated tritium supply and recycling facility. Impacts would be less since 202 fewer acres of habitat would be disturbed.

*Less Than Baseline Operations.* Operation of the HWR, MWTGR or ALWR at reduced tritium production capacity would have the same impacts described above for production at baseline tritium requirements.

Construction-related impacts of the less than baseline tritium requirement Phased APT would be similar to those described above. Some additional construction-related impacts could occur if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion activities would occur in the already developed main plant site.

*Potential Mitigation Measures.* Loss of habitat due to construction and operation of any of the tritium supply technologies and recycling facilities may be mitigated by returning land to agricultural use or revegetating disturbed areas, as appropriate. Disturbance to wildlife living in areas adjacent to the new facilities may be reduced by limiting worker access to these areas. It may be necessary to survey the proposed TSS for the nests of migratory birds prior to clearing operations and/or avoid clearing operations during the breeding season.

**Wetlands.**

*No Action.* Under No Action, the missions described in section 3.3.4 would continue. No new impacts to wetlands would occur. Wastewater discharges to Playas 1, 2, and 4 would continue in compliance with the current Texas Natural Resources Conservation Commission permit and the pending NPDES permit.

*Tritium Supply and Recycling.* Impacts to wetlands (e.g., sedimentation) may result from land disturbances and treated wastewater disposal during construction. Construction-related ground disturbance increases the potential for sediment runoff to the playa wetlands. This impact would be controlled through the implementation of standard soil erosion and sediment control measures. Playas 1 through 5 would be avoided during construction. Depending

on the final site layout, smaller areas of potential wetlands indicated on site National Wetlands Inventory maps could be impacted. Determination of the extent and jurisdictional status of these small wetlands would require site evaluation and concurrence by the U.S. Army Corps of Engineers. Any potential impacts to wetlands resulting from construction activities would be mitigated according to U.S. Army Corps of Engineers requirements.

During construction, the HWR, MHTGR, ALWR, or APT would discharge treated wastewater to the playas (section 4.5.3.4). Part of the discharge water would be lost to the atmosphere due to the high regional evapotranspiration rate. However, temporary impacts to the playas could include shifts in the composition of wetland plant communities and limited increases in the area of open water. The plant community shifts would favor plants tolerant of longer and deeper inundation. Furthermore, disturbed plant communities provide an opportunity for establishment of invasive exotic plant species. These changes would alter the naturally occurring ephemeral wetland system characteristic of the playas.

During operation of any of the four technologies, treated wastewater would be discharged to the playa basins (section 4.5.3.4). The discharge of wastewater to the playas could adversely affect the playa ecosystem. Impacts to playa wetlands could include shifts in the composition of wetland plant communities, opportunities for establishment of exotic vegetation, and increases in the areas of open water. Any discharge to the playa(s) would be required to conform to water quality requirements of NPDES and Texas Natural Resources Conservation Commission permits. For the APT tritium supply alternative it is also possible, depending on the location of the cooling tower, that salt drift could impact wetlands. Impacts to wetlands would depend upon the sensitivity of plant species present, but could lead to a shift is species composition.

Construction and operation of a tritium supply facility alone would result in similar impacts to wetlands but slightly less than those described for a collocated tritium supply and recycling facility. This is the case since both land and water requirements would be less.

*Less than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have similar wetland impacts described above for production at baseline tritium requirements. Construction and operation of a Phased APT would have similar wetland impacts but potentially slightly less than the Full APT.

*Potential Mitigation Measures.* Construction and operation activities would be designed to avoid or minimize, as much as possible, any potential impacts to wetlands. Any unavoidable impacts would be mitigated according to DOE policy set forth in 10 CFR 1022 and in accordance with U.S. Army Corps of Engineers requirements. Mitigation could include creation of lined evaporation ponds to limit areas of open water in playas or restoration or creation of compensatory wetlands to offset any unavoidable wetland losses. All effluent discharges to wetlands would be regulated through the provision of NPDES and Texas Natural Resources Conservation Commission permits.

**Aquatic Resources.**

*No Action.* Under No Action, the missions described in section 3.3.4 would continue. This would not change the condition of aquatic resources at Pantex.

*Tritium Supply and Recycling.* Construction of tritium supply technologies and recycling facilities would result in discharges of wastewater to the playas. As discussed for wetlands, the discharges could potentially result in a small increase in open water area. During construction, aquatic communities resulting from the creation of open water bodies would be temporary in nature. Playas could also be affected by sediment runoff during construction; however, this impact would be controlled through the use of soil erosion and sediment control measures.

During operation, discharges to playas would not be sufficient to create large permanent areas of aquatic habitat, but may increase the availability of habitat for amphibians. Discharges to playas would conform to the requirements of NPDES and Texas Natural Resources Conservation Commission permits.

Construction and operation of a tritium supply facility alone would result in similar impacts to playas, but slightly less than those described for a

collocated tritium supply and recycling facility. This is the case since both land and water requirements would be less.

*Less than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would have similar impacts to aquatic resources at Pantex. Construction and operation of a Phased APT would have similar aquatic resource impacts, but potentially slightly less than the Full APT.

*Potential Mitigation Measures.* Potential impacts to aquatic resources would be mitigated through the implementation of a soil erosion and sediment control plan. All discharges would be required to meet NPDES and Texas Water Commission permit requirements.

**Threatened and Endangered Species.**

*No Action.* Under No Action, the missions described in section 3.3.4 would continue. There would be no changes to the current status of threatened and endangered species at Pantex described in section 4.5.2.6.

*Tritium Supply and Recycling.* The bald eagle is the only consistently occurring Federal-listed species that has the potential to be affected by construction activities. Bald eagles avoid areas where humans are active; thus, wintering eagles would not be expected to forage at playas during project construction.

Six Federal candidate (Category 2) species may be affected by construction activities. Similar to the bald eagle, the black tern and white-faced ibis may be discouraged from foraging at site playas during construction. The ferruginous hawk also would lose some foraging habitat (i.e., grasslands and agricultural areas) and the possible disturbance of prairie dog towns could reduce a relied upon food source. The swift fox and loggerhead shrike would also lose potential foraging and denning or nesting habitat. The Texas horned lizard is less mobile and would be destroyed during land-clearing activities. Preactivity surveys would be required prior to construction to determine the occurrence of these species in the area to be disturbed.

During operation, the ferruginous hawk and swift fox would not use areas in close proximity to the operating plant. New fencing would create foraging lookout perches for loggerhead shrikes.

Construction and operation of a tritium supply facility alone would result in similar impacts to threatened and endangered species, but slightly less than those described for a collocated tritium supply and recycling facility. Impacts would be less since fewer acres of habitat would be disturbed.

*Less than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced tritium production capacity would be expected to result in similar impacts to threatened, endangered, or sensitive species as described for the baseline tritium production requirement. Construction and operation of a Phased APT would also have similar impacts on these species.

*Potential Mitigation Measures.* Since most impacts are temporary in nature, few mitigative efforts would be required for threatened and endangered species that may occur at Pantex. Consultation with the USFWS would be pursued as required and, if deemed necessary, a detailed plan to mitigate impacts to Federal-listed threatened and endangered species at Pantex would be developed. No critical habitat has been designated for threatened and endangered species at Pantex.

#### 4.5.3.7 *Cultural and Paleontological Resources*

Cultural and paleontological resources may be affected directly through ground disturbance during construction, building modifications, visual intrusion to the historic setting or environmental context, visual intrusion to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Intensive cultural resources surveys and site evaluations have not been completed for Pantex. Site-specific surveys and evaluations will continue in conjunction with tiered NEPA documentation. Although the location and acreage for the proposed tritium supply plant or the combined tritium supply and recycling facilities will vary, their potential effects on cultural and paleontological resources are based primarily on the amount of ground disturbance; therefore, the facilities with the greatest ground disturbance will have the greatest potential effect on cultural and paleontological resources. A small number of NRHP-eligible

historic or prehistoric properties, or important Native American or paleontological resources may be affected by the proposed action.

**Prehistoric and Historic Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at Pantex. Any impacts to prehistoric and historic resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Land disturbance at Pantex for the proposed tritium facilities (section 3.4) would range from 173 acres for the APT to 360 acres for the MHTGR (section 4.5.3.1). Acreages for the HWR and ALWR would be 260 and 350, respectively. Acreage required by the recycling facilities would be an additional 196 acres. Potentially NRHP-eligible prehistoric or historic archaeological properties may occur within the acreages that would be disturbed during construction. Such NRHP-eligible properties would be identified through project-specific inventories and evaluations, and any project-related effects would be addressed in tiered NEPA documentation. Operation of facilities does not involve additional ground disturbance, increased activity or building modification; therefore, prehistoric or historic properties would not be affected.

*Less Than Baseline Operations.* No change in impacts to prehistoric and historic resources would be expected from operating the HWR at reduced capacity. Impacts for the MHTGR or ALWR would also not change from those described for the baseline requirement because the MHTGR or ALWR would not be a reduced size or operate at reduced capacity.

Construction and operation of the Phased APT would not change the expected impacts from the baseline tritium requirement since the disturbed area would be the same.

*Potential Mitigation Measures.* If any NRHP-eligible properties cannot be avoided through project design or siting, and would result in an adverse effect, then a Memorandum of Agreement would need to be negotiated among DOE, the Texas SHPO, and the Advisory Council on Historic Preservation, describing and implementing intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs. The appropriate level of data recovery for mitigation would be determined through consultation with the Texas SHPO and the Advisory Council on Historic Preservation, in accordance with Section 106 of the *National Historic Preservation Act.*

**Native American Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at Pantex. Any impacts to Native American resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Some Native American resources would occur within any areas disturbed during construction of the tritium supply plant or combined tritium supply and recycling facilities. Such resources may include campsites, ritual or traditional use areas, or burials. Operation of tritium facilities may create visual intrusion on sacred sites in the vicinity or reduce access to traditional use areas. Specific concerns about the presence, type, and locations of Native American resources would be identified through consultation with affected Native American groups, and any project-related effects would be addressed through direct consultation with the affected group(s) in tiered NEPA documents.

*Less Than Baseline Operations.* Impacts to Native American resources would not change due to less than baseline operation of the HWR, MHTGR or ALWR. Construction and operation of a Phased APT would have similar impacts on Native American resources as those described for the baseline requirement Full APT.

*Potential Mitigation Measures.* If Native American resources cannot be avoided through project design or siting, then acceptable mitigation measures to reduce project effects on them would be determined in consultation with the affected Native American groups. In accordance with the *Native American Graves Protection and Repatriation Act* and the *American Indian Religious Freedom Act,* such mitigations may include, but not be limited to, appropriate relocation of human remains, planting vegetation screens to reduce visual intrusion, or transplanting or harvesting important Native American plant resources.

**Paleontological Resources.**

*No Action.* Under No Action, DOE would continue existing planned missions at Pantex. Any impacts to paleontological resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply and Recycling.* Paleontological resources may occur within the acreages disturbed during construction of the tritium supply plant or combined tritium supply and recycling facilities. Any project-related effects to scientifically important paleontological resources would be identified in tiered NEPA documentation and addressed through project-specific evaluation studies. Operation of tritium facilities does not involve additional ground disturbance or increased activity; therefore, paleontological resources would not be affected.

*Less Than Baseline Operations.* No change in impacts to paleontological resources would be expected due to reduced operation of the HWR, MHTGR or ALWR. Construction of a Phased APT may potentially have a slightly smaller impact on paleontological resources due to less excavation for APT tunnel length.

*Potential Mitigation Measures.* Because scientifically important buried paleontological materials could be affected, paleontological monitoring of construction activities and data recovery of fossil remains would be appropriate mitigation measures.

### 4.5.3.8 *Socioeconomics*

Locating any of the tritium supply technologies alone or with recycling facilities at Pantex would affect socioeconomics in the region. Section 3.2 provides descriptions for No Action, the tritium supply technologies, and tritium recycling. Siting a tritium supply technology with or without the recycling facilities at Pantex would create changes in some of the communities in both the ROI and the economic study area. The in-migrating population could increase the demand for housing units. Additionally, there could be an associated increased burden on community infrastructure and subsequent effects on the public finances of local governments in the ROI. The increase of population could also burden transportation routes in the ROI.

Locating the ALWR at Pantex would create the greatest changes during construction, but locating the MHTGR, HWR, or ALWR would result in similar changes during operation. The APT would cause the fewest changes of the tritium supply technologies. None of these tritium supply technologies would increase population, the need for additional housing, or local government spending in the ROI beyond 7 percent over No Action during peak construction or operation. Although the greatest percent increases in employment, population and housing, and public finance during construction and operation occur in the peak years of 2005 and 2010, respectively, the annual average increases over the construction period (2001 to 2005) are between 1 percent and 3 percent average growth annually and less than 1 percent average annual growth during operation (2010 to 2050). Between peak construction (2005) and full operation (2010) annual average growth would vary from decreases of 1 percent to increases of 1 percent. None of the annual average increases associated with the tritium supply technologies and recycling facilities constitutes a major difference from the No Action annual average increases.

The effects of locating any of the tritium supply technologies alone or with recycling facilities at Pantex are summarized in section 4.5.3. The following sections describe the effects that locating one of these technologies would have on the local region's economy and employment, population, housing, public finances, and local transportation.

**Employment and Local Economy.** Changes in employment and levels of economic activity in the 15-county economic study area from the proposed location of a tritium supply technology and recycling facility at Pantex are described in this section. Although specialized personnel, materials, and services required for construction and operation would be imported from outside the area, a significant portion of these requirements would be available in this economic study area. Figures 4.5.3.8–1 and 4.5.3.8–2 present the potential changes in employment and local economy that would occur with all of the technologies.

*No Action.* Under No Action, employment at Pantex increased to approximately 3,400 persons in 1994. This is an increase of approximately 1,000 persons over the 1990 employment. Pantex employment is projected to decrease to 1,790 persons in 2010 and remain at this level through 2020. Historical and future employment projections at Pantex are found in appendix table D.2.1–1. The total Pantex payroll was approximately $174 million in 1994 and is projected to decrease to $85 million in 2010.

Total employment in the economic study area is projected to grow less than 1 percent annually between 2001 and 2009, reaching 167,800 persons, and then decrease slightly (much less than 1 percent) annually between 2010 and 2020, reaching 162,000 persons. The unemployment rate in the economic study area is expected to remain at 4.6 percent between 2001 and 2020. Per capita income is projected to increase from $22,300 to $25,700 during this 20-year period. No Action estimates are presented in appendix table D.3–53.

*Tritium Supply and Recycling.* Construction activities would begin between the years 2001 and 2003 and would be completed between the years 2007 and 2009. Phasing in of employment for the operation of the new facilities would begin in the year 2007 or 2008, peak at full employment by the year 2010, and continue at this level into the future.

Locating any of the tritium supply technologies and recycling facilities at Pantex would create new jobs (direct) at the site. Indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new jobs. The total new jobs (direct and indirect) created would

reduce unemployment and increase income in the economic region surrounding Pantex during both the construction and operation periods of the proposed action.

Construction. Siting tritium supply technologies and recycling facilities at Pantex would require a total of approximately 4,400 to 13,600 worker-years of activity over a 5- to 9-year construction period. This construction-related employment would indirectly create other jobs in the economic study area and total employment would grow at an annual average rate of 1 to 2 percent until the peak year of 2005. Between 2005 and 2010, annual growth would be flat. Figure 4.5.3.8–1 gives the estimates of total jobs (direct and indirect) that would be created during peak construction (year 2005) for each of the tritium supply technologies with recycling and the recycling facility's contribution to employment growth.

As employment opportunities grow in the economic study area due to the proposed action, the unemployment rate would be reduced from the No Action estimate of 4.6 percent. Figure 4.5.3.8–2 presents a comparison of unemployment rates for the different tritium supply technologies and recycling during peak construction in the year 2005. During the project's peak construction phase, the unemployment rate would range from a high of 2.7 percent to 2.2 percent, depending upon the tritium supply technologies with recycling selected.

Income in the economic study area would also increase, particularly during peak construction, as shown in figure 4.5.3.8–2. Per capita income is expected to increase at an annual average of 1 percent until the peak construction year (2005) and between 2005 and 2010.

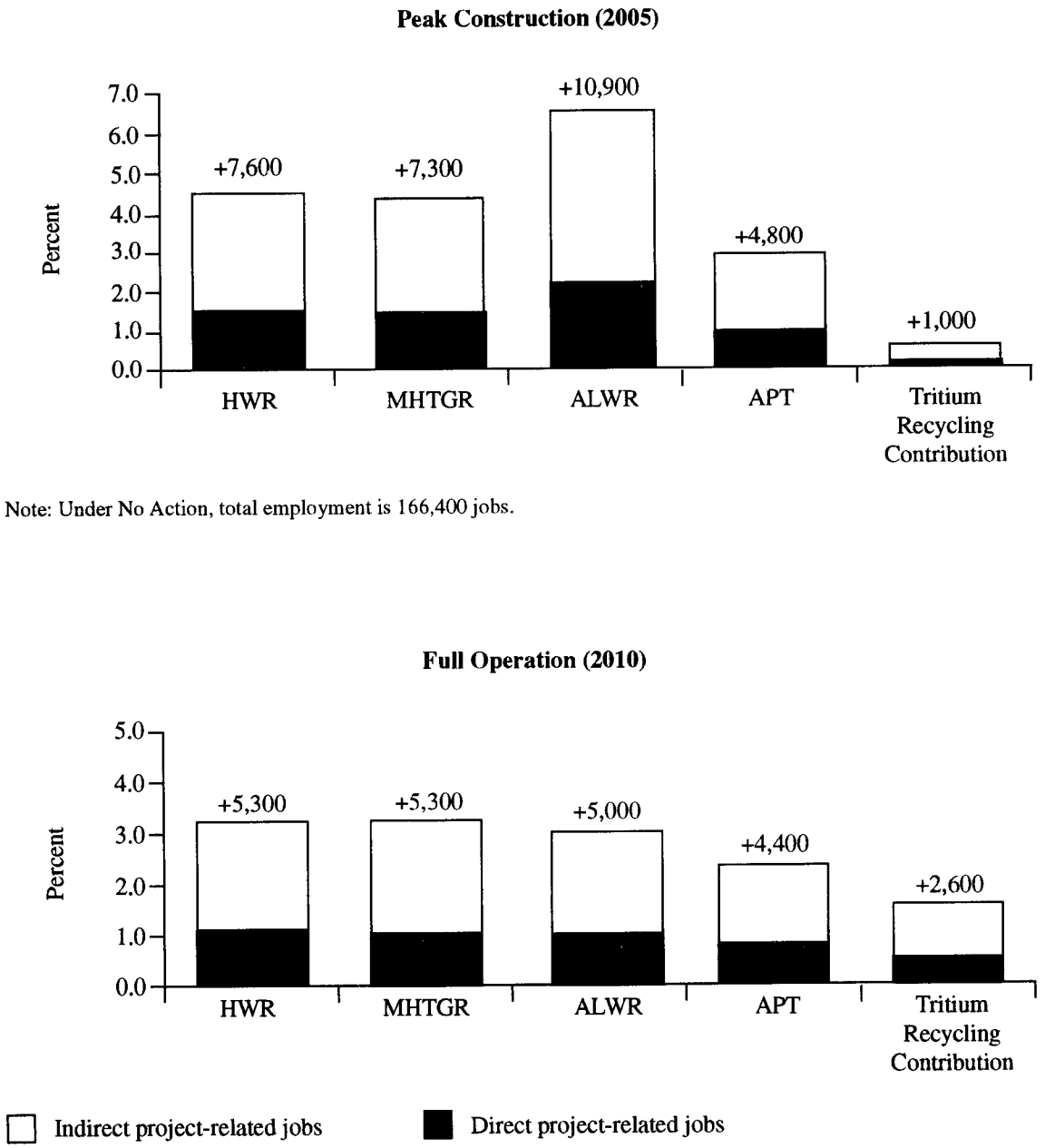
Operation. Employment for operation would begin phasing in as construction neared completion and the construction-related employment would begin phasing out. It is expected that full operation employment would peak in the year 2010 and continue at this level into the future. Figure 4.5.3.8–1 gives the total project-related jobs projections (direct and indirect) for each of the tritium supply technologies and recycling facilities for the year 2010. Total employment in the economic study area would decrease slightly over the next 10 years at an annual average decrease of less than 1 percent, similar to the No Action annual rate of decrease.

Creation of additional job opportunities would reduce the unemployment rate below that projected for No Action. Figure 4.5.3.8–2 presents the differences in unemployment rates during the first year of full operation employment (2010) for each of the tritium supply technologies and recycling facilities. From the years 2010 to 2020, unemployment would be reduced from the No Action projection of 4.6 percent to between 2.8 and 2.5 percent, depending upon the technology selected for the proposed action.

Income would also increase slightly in the economic study area as a result of the proposed action. Per capita income differences for tritium supply technologies and recycling facilities for the year 2010 are given in figure 4.5.3.8–2. Per capita income annual average increases would be less than 1 percent between the years 2010 to 2020 for any of the tritium supply technologies and recycling facilities located at Pantex. The No Action projected annual average increase during the same period would also be less than 1 percent.

*Tritium Supply Alone.* Construction of a tritium supply technology only without a recycling facility would begin between 2001 and 2003 and would be completed between 2007 and 2009. Employment for the operation of the facility would begin in the year 2007 and reach full employment by 2010. Locating any of the tritium supply technologies at Pantex would create new jobs at the site and indirectly create other jobs in the region. However, this job creation and the additional economic effects that would occur would be less than the effects expected with the collocation of tritium supply with the recycling facility.

Construction. Construction of a tritium supply technology only would require a total of 3,400 to 12,600 worker-years of activity over a 5- to 9-year period. New jobs would be created, but this employment growth would be less than 1 percent over No Action estimates. Appendix table D.3-54 presents the estimates of total employment that would be created during peak construction in 2005, or these new jobs can be calculated by subtracting the tritium recycling contribution from tritium supply technologies and recycling in figure 4.5.3.8–1.




Note: Under No Action, total employment is 166,400 jobs.

Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. Under No Action, total employment is 168,150 jobs. The percent increase in total employment during construction and operations was calculated by dividing the total project-related jobs by the total employment under No Action.

Source: Appendix table D.3–55.

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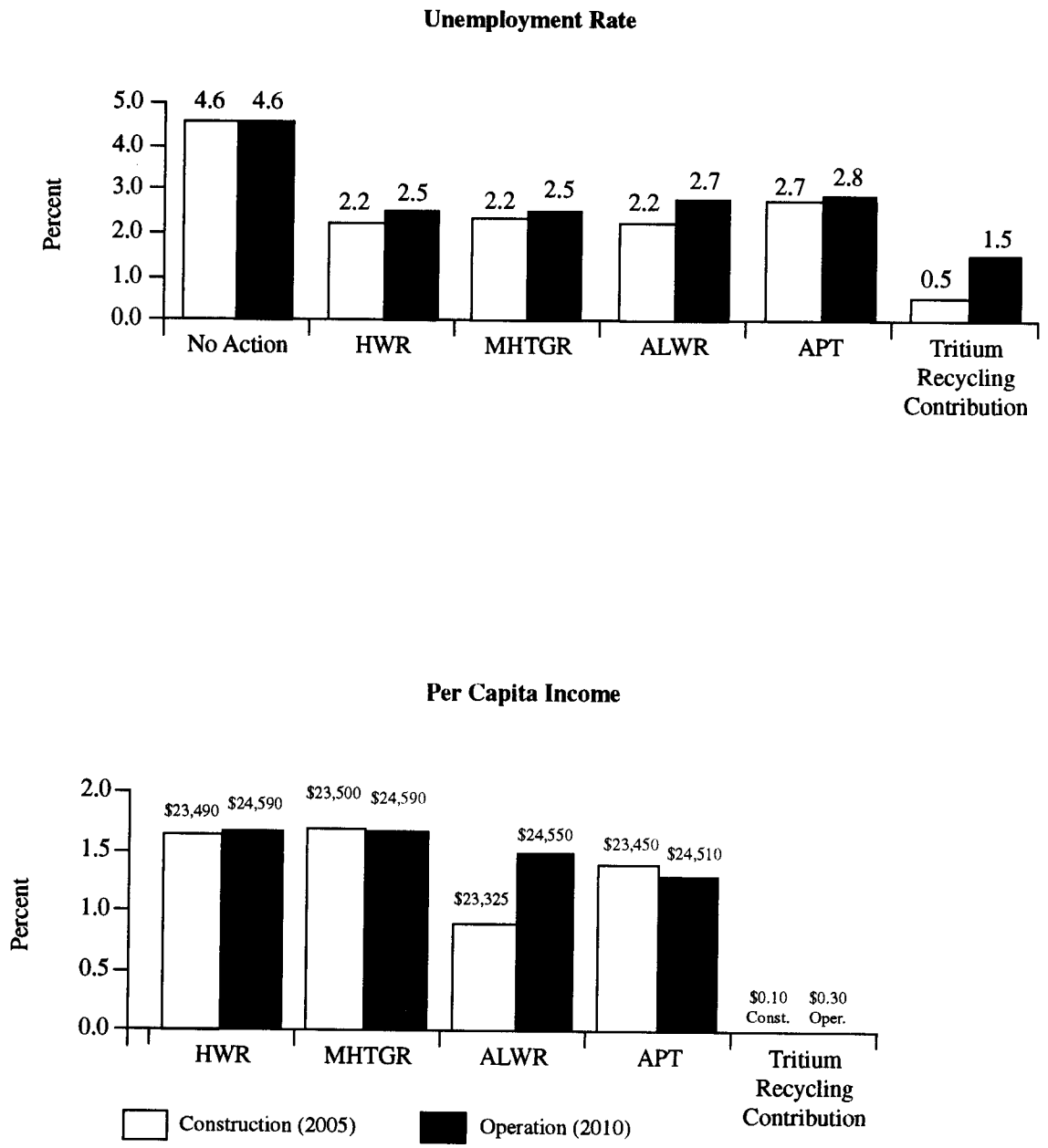
**FIGURE 4.5.3.8–1.—*Total Project-Related Employment (Direct and Indirect) and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling for Pantex Plant Economic Study Area.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution.

Note: Under No Action per capita income is projected to be $23,130 in 2005 and $24,200 in 2010.

Source: Appendix table D.3–55.

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**FIGURE 4.5.3.8–2.—*Unemployment Rate, Per Capita Income, and Percentage Increase Over No Action from Tritium Supply Technologies and Recycling for Pantex Plant Economic Study Area.***

Although the construction of the facility would create new jobs, the effects would not be enough to greatly affect the unemployment rate projected for No Action. Additionally, per capita income in the region would rise only slightly above the per capita income increase estimated for No Action. Estimates of unemployment rate and per capita income are presented in appendix table D.3-54 or can be derived for tritium supply alternatives by subtracting the tritium recycling contributions in figures 4.5.3.8–2.

Operation. Operation employment for the tritium supply technology only would begin phasing in at the end of the construction period and be at full employment in the year 2010. Full employment is expected to be maintained for the life of the facility. Estimates for full employment in 2010 are presented in appendix table D.3-54. Total project related jobs (direct and indirect) for the tritium supply technologies alone can be calculated by subtracting the tritium supply contribution in figure 4.5.3.8–1.

The addition of new jobs during operation would reduce the unemployment rate below the projection for No Action. The unemployment rate for 2010, the first year of full operation employment, is given in appendix table D.3–54 or can be derived by subtracting the tritium recycling contribution in figure 4.5.3.8–2.

The creation of new jobs as a result of the tritium supply operation would also increase income slightly over the No Action estimates. Appendix table D.3-54 gives the per capita income for the tritium recycling facility for the year 2010. Per capita income growth can also be calculated by subtracting the tritium recycling contribution in figure 4.5.3.8–2. During the years 2010 to 2020, per capita income annual increases would be 1 percent, the same annual increase projected under No Action.

*Less Than Baseline Operation.* Tritium supply technologies that provide less than the baseline tritium operation capacities are described in section 3.1. These options may or may not be collocated with the tritium recycling facilities. The options include lowering the power in the HWR, using fewer target rods in the MHTGR or ALWR, and the phased approach for the APT.

Construction. The less than baseline operations case for the HWR, MHTGR, and ALWR would have the same construction workforce requirements as discussed in the tritium supply and recycling and tritium supply only sections. Therefore, employment and economic effects in the region would be the same.

The Phased APT would require the same total number of construction workers as the Full APT, but the construction period would span the years 1999 to 2008 instead of 2003 to 2007. Additionally, peak construction would occur in 2003 instead of 2005. The effects on the economic study area's employment, unemployment rate, and per capita income as a result of constructing the Phased APT are presented in appendix table D.3-54. Appendix table D.3-55 presents the effects on employment, unemployment rate, and per capita income for constructing the Phased APT with tritium recycling facilities. Generally, average annual increases in employment and income would be similar to those for the Full APT, but these increases are over a longer period of time. These increases are between less than 1 percent and 2 percent, the same as the No Action estimates.

Operation. Operation workforce requirements for the less than baseline tritium requirement case for the HWR, MHTGR, ALWR, and the Phased APT would be the same as those described in the tritium supply and recycling and tritium supply only sections. Thus, regional employment and economic effects would be the same.

**Population and Housing.** Changes to ROI population and housing expected from the proposed action are described in this section. Additional population could be expected to in-migrate to the Pantex region and these people would be expected to reside in cities and counties within the ROI in the same relative proportion as the existing population. Increases to population could lead to a demand for additional housing units beyond existing vacant housing available during construction or operation phases of the proposed action. Figures 4.5.3.8–3 and 4.5.3.8–4 present the changes in population and housing over No Action with tritium supply technologies and recycling facilities.

*No Action.* Population and housing annual average increases between 2001 and 2009 are projected to be

less than 1 percent. Future annual average increases are also projected to be much less than 1 percent between 2010 and 2020. Population in the ROI is estimated to reach 205,100 in 2010 and 209,000 in 2020. Total housing units in the ROI are estimated to reach 88,400 in 2010 and 90,000 in 2020. No Action estimates are presented in appendix tables D.3–56 and D.3–59.

*Tritium Supply and Recycling.* It is expected that the proposed action at Pantex would increase population and housing demands in the ROI (7 percent) over No Action projections during peak construction. The effects are expected to be fewer (2 percent) during the operation phase of the proposed action.

Construction. Construction activities would be phased over a 5- to 9-year period. Figure 4.5.3.8–3 illustrates that during peak construction (year 2005), the ALWR would create the largest population and housing demand increases over No Action, and the APT would have the least effects. The increase in population could require some additional housing units beyond what is currently available in the existing housing mix. However, any requirements for additional housing units would be at annual average increases of less than 1 percent in the first 3 years of construction of the ALWR, followed by an approximately less than 1 percent decrease until peak operation. The other tritium supply technologies would also have annual average population and housing demand growth of less than 1 percent. Therefore, there would not be any major effects on any of the ROI communities.

Operation. Operation of a tritium supply technology and recycling facility is expected to reach full employment by 2010. In-migrating population is expected to demand housing units similar to the existing housing mix in the ROI. Figure 4.5.3.8–4 shows the population increases and potential demand for additional housing units over No Action projections (much less than 1 percent) in this peak year. Given that the operation of the proposed action would be phased in over a 4-year period, it is expected that existing vacancies would absorb much of this new demand and that No Action requirements would be exceeded by very few units.

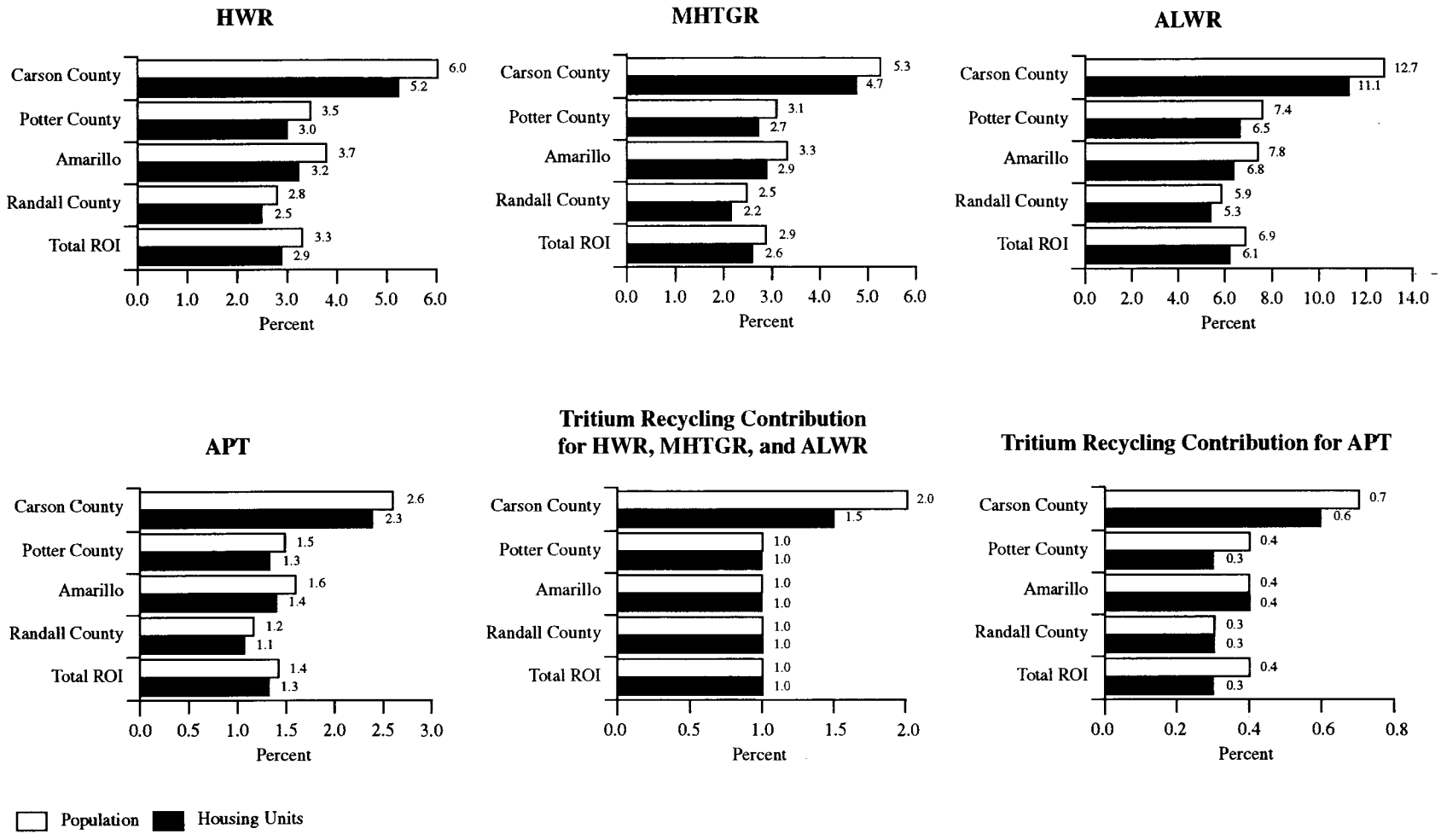
*Tritium Supply Alone.* Locating only a tritium supply technology at Pantex would not increase population or housing demands in the ROI more than 6 percent over No Action projections during the construction or operation periods.

Construction. Construction activities for the tritium supply technology alone would be much lower than if collocated with the tritium recycling facilities. The greatest increase in population and housing demand would occur during peak construction in 2005. Appendix tables D.3-57 and D.3-60 show that available vacancies in the existing housing mix would probably accommodate the expected population growth. Estimated growth in the ROI is much less than 1 percent over the No Action projection.

Operation. Full employment levels for tritium supply only would be reached by the year 2010. Inmigrating population would be expected to require housing units similar to the existing mix in the ROI, but these requirements would be lower than those for any of the tritium supply technologies with the recycling facilities. Potential demand for housing units is very small (much less than 1 percent) in the first year of full employment as illustrated in appendix tables D.3–57 and D.3–60. It is expected that existing vacancies would absorb most of this new demand as employment would be phased in during the years 2007 through 2010.

*Less Than Baseline Operations.* Population increases and housing demands would be the same or lower during construction and operation of tritium supply technologies operated at less than baseline tritium requirements than the alternatives discussed in the tritium supply and recycling and tritium supply only sections.

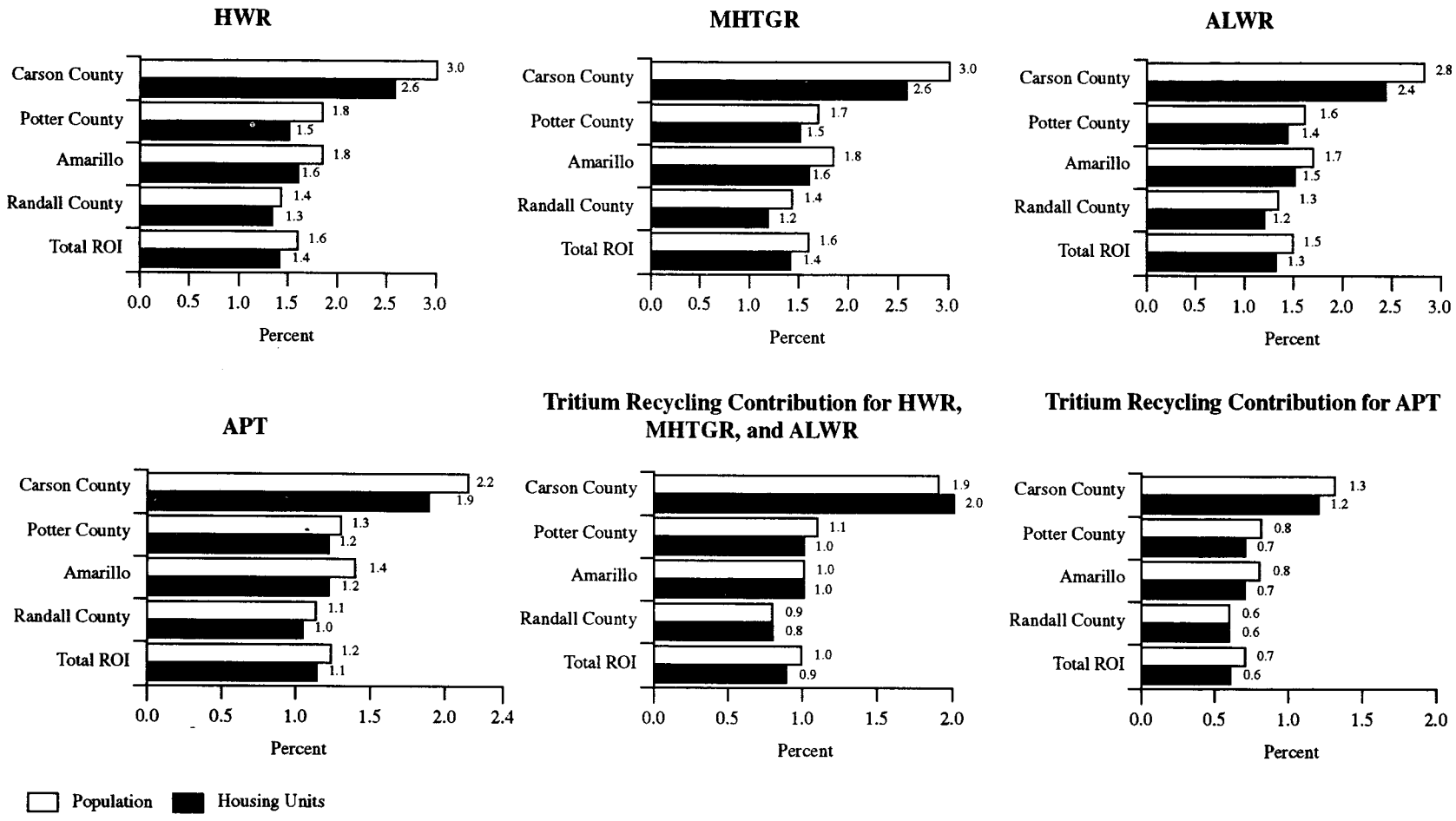
Construction. Population increases and housing demands would be the same as those given in figure 4.5.3.8–3 for the HWR, MHTGR, and ALWR. The Phased APT would increase population and housing demand during construction to the same level as the Full APT, but this would occur over a longer construction period with lower average annual increases. Also, the peak construction year would be 2003 instead of 2005. The effects of the Phased APT on population and housing are given in appendix tables D.3-57 and D.3-60, respectively. Appendix tables D.3-58 and D.3-61 present the results of constructing the Phased APT with the tritium recycling facilities.




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–57, D.3–58, D.3–60 and D.3–61.

Source: Appendix tables D.3–58; D.3–61.

**FIGURE 4.5.3.8–3.**—***Total Population and Housing Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For county and city population and housing breakdowns, see appendix tables D.3–57, D.3–58, D.3–60, and D.3–61.

Source: Appendix tables D.3–58 and D.3–61.

**FIGURE 4.5.3.8–4.—*Total Population and Housing Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2010.***

Operation. The effects on population and housing of operating the HWR, MHTGR, ALWR, and Phased APT at less than baseline tritium requirements would be the same as those given in figure 4.5.3.8–4.

**Public Finance.** Fiscal changes could occur in some ROI local jurisdictions from the proposed action. Factors influencing these changes include residence of project-related employees and their dependents, cost and duration of construction, and economic conditions in the ROI once the new facilities are operational.

Adding the proposed action to Pantex would increase population, resulting in more revenues for ROI local jurisdictions. Additional population would also increase public service expenditures. Figures 4.5.3.8–5 through 4.5.3.8–8 present the potential fiscal changes that would occur with the different tritium supply technologies and recycling facilities.

*No Action.* Appendix tables D.3–62 and D.3–63 present the 1992 public finances for ROI local jurisdictions. Appendix tables D.3–64 through D.3–67, and D.3–68, through D.3–71 present the impacts from the tritium supply technologies with or without recycling facilities compared to No Action during construction and operation for the local counties, cities, and school districts. Between 2001 and 2005, most ROI counties, cities, and school districts are projected to increase total revenues on an annual average of less than 1 percent. Total expenditures are projected to increase on an annual average of less than 1 percent for all ROI counties, cities, and school districts between 2001 and 2005.

Between 2010 and 2020, projected annual average increases in total revenues are less than 1 percent for most counties, cities, and school districts in the ROI. Total expenditures are projected to increase, on an average, by less than 1 percent for ROI jurisdictions between 2010 and 2020.

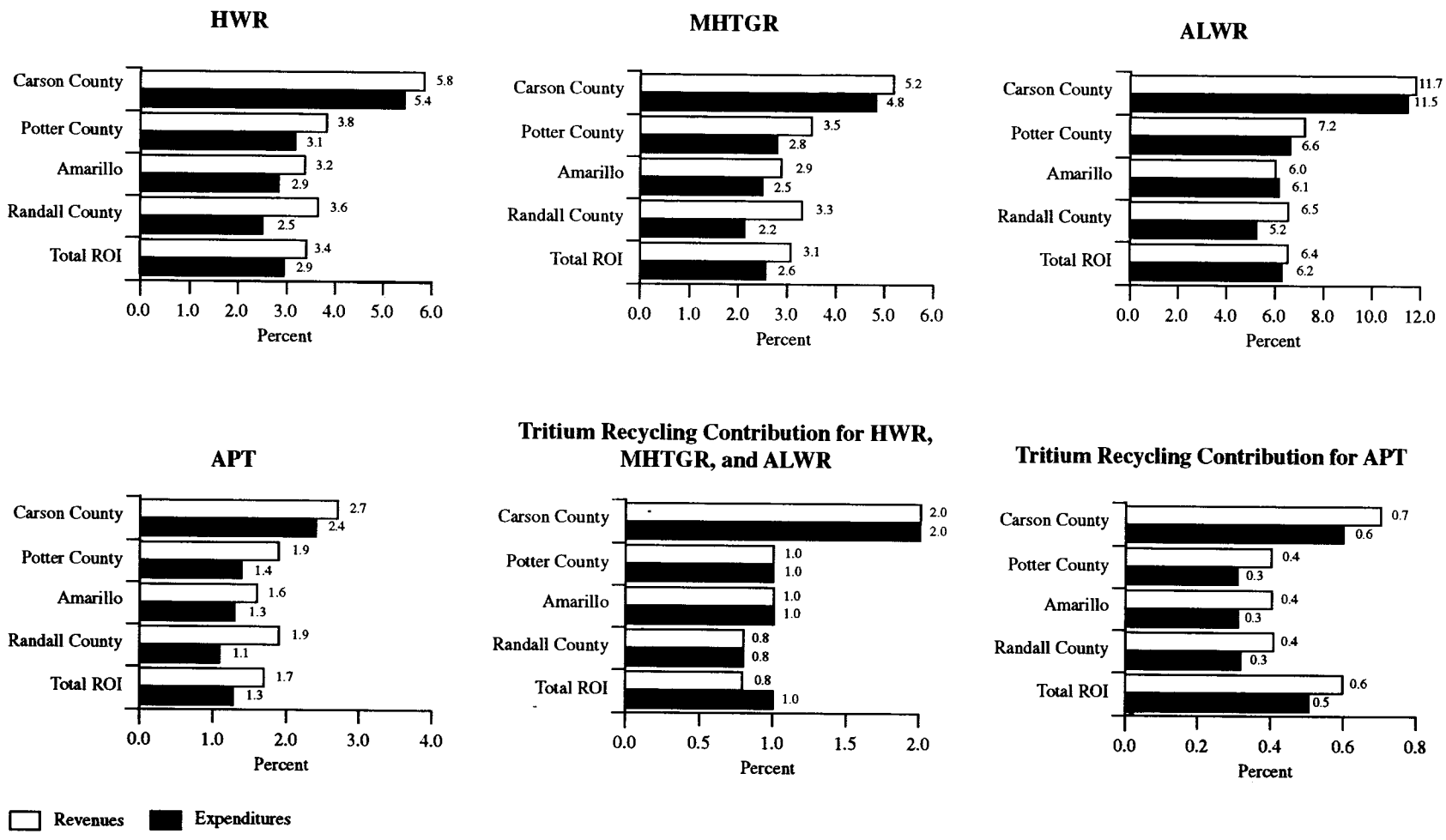
*Tritium Supply and Recycling.* The proposed action at Pantex would create some fiscal benefits to local jurisdictions within the ROI. Some local government finances would be affected during the construction and operation phases of the proposed action. Construction-related effects on revenues and expenditures could span a period of 5 to 9 years with the peak occurring in 2005. The effects of the operation phase would peak in 2010 and remain at this level throughout the life of the proposed action.

Construction. The public finances of counties, cities, and school districts within the ROI would be affected by the construction-related activities associated with the proposed action. Initially, there would be slight increases to some local government jurisdictions' revenues and expenditures, which would peak in the year 2005 and then decline as construction neared completion. Figures 4.5.3.8–5 and 4.5.3.8–7 give the revenue and expenditure changes of the ROI local government jurisdictions over No Action during peak construction for the four tritium supply technologies and recycling facilities. Over the construction phase of the proposed action, revenues and expenditures would increase at an annual average of 1 percent to 3 percent. Between 2005 and 2010 total revenues and expenditures in the ROI would decrease 1 percent annually. Under the No Action estimates, local government revenues and expenditures would increase on an annual average of less than 1 percent until peak construction (2005) and between 2005 and 2010.

Operation. The effects on the ROI local government finances of phasing in operation together with the phasing out of construction would be fewer than the effects at peak or full operation (year 2005). The effects that the four tritium supply technologies and recycling facilities would have on county, city, and school district revenues and expenditures are presented in figures 4.5.3.8–6 and 4.5.3.8–8. Between 2010 and 2020, revenues are expected to increase slightly at an average annual rate of less than 1 percent for all ROI jurisdictions. Expenditures would also increase through the year 2020 at an annual average of less than 1 percent. No Action local government revenues would also increase at an average annual rate of less than 1 percent, and expenditures would grow annually at less than 1 percent.

*Tritium Supply Alone.* Locating the tritium supply without the recycling facilities at Pantex would create some fiscal benefits to local jurisdictions within the ROI, but these effects would be less than the effect of collocation with tritium recycling.

Construction. Construction-related effects on the revenues and expenditures of counties, cities, and school districts would be less than the effects from locating tritium supply technologies with recycling




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–68.

Source: Appendix table D.3–68.

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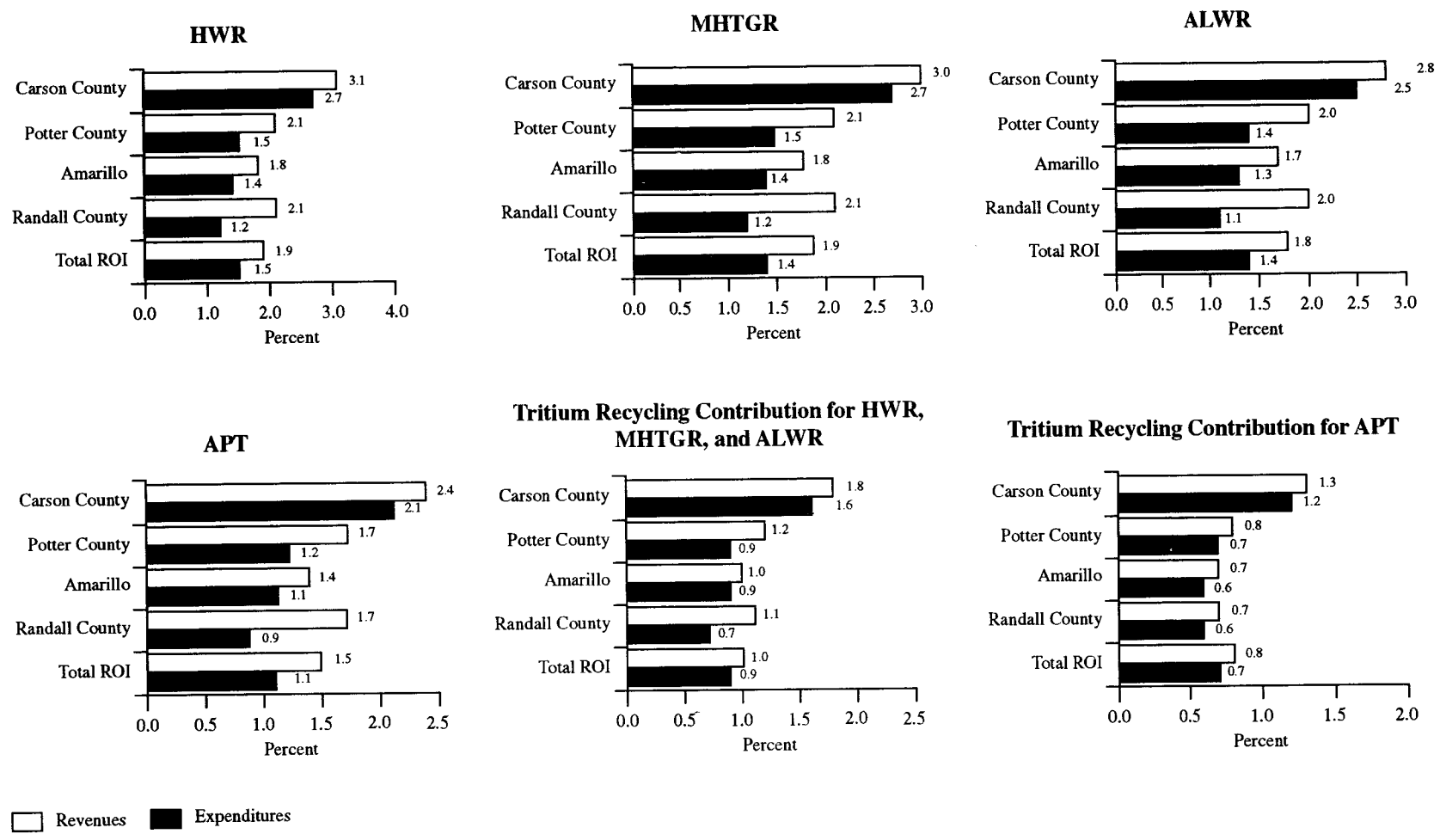
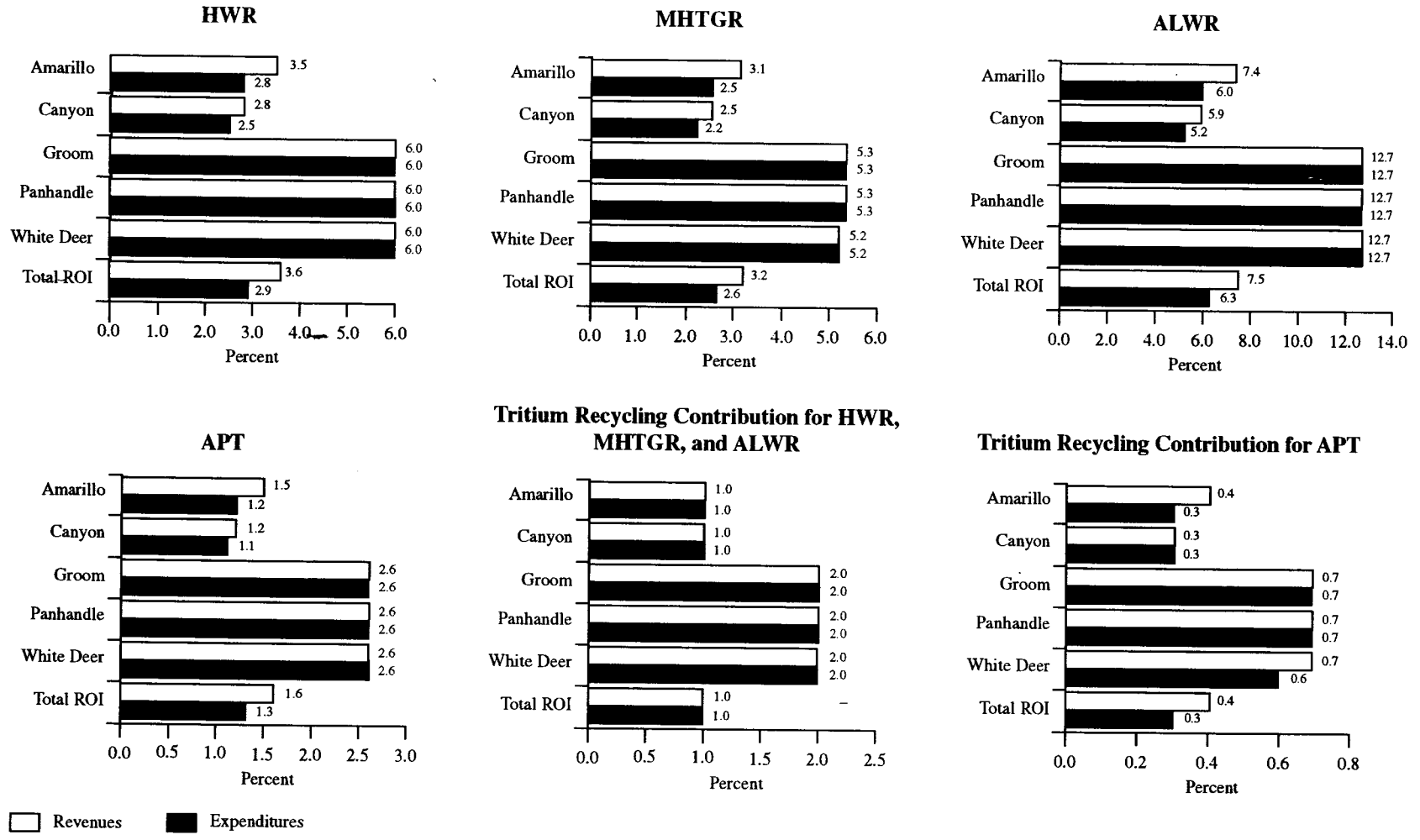
**FIGURE 4.5.3.8–5.—*County and City Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–69.

Source: Appendix table D.3–69.

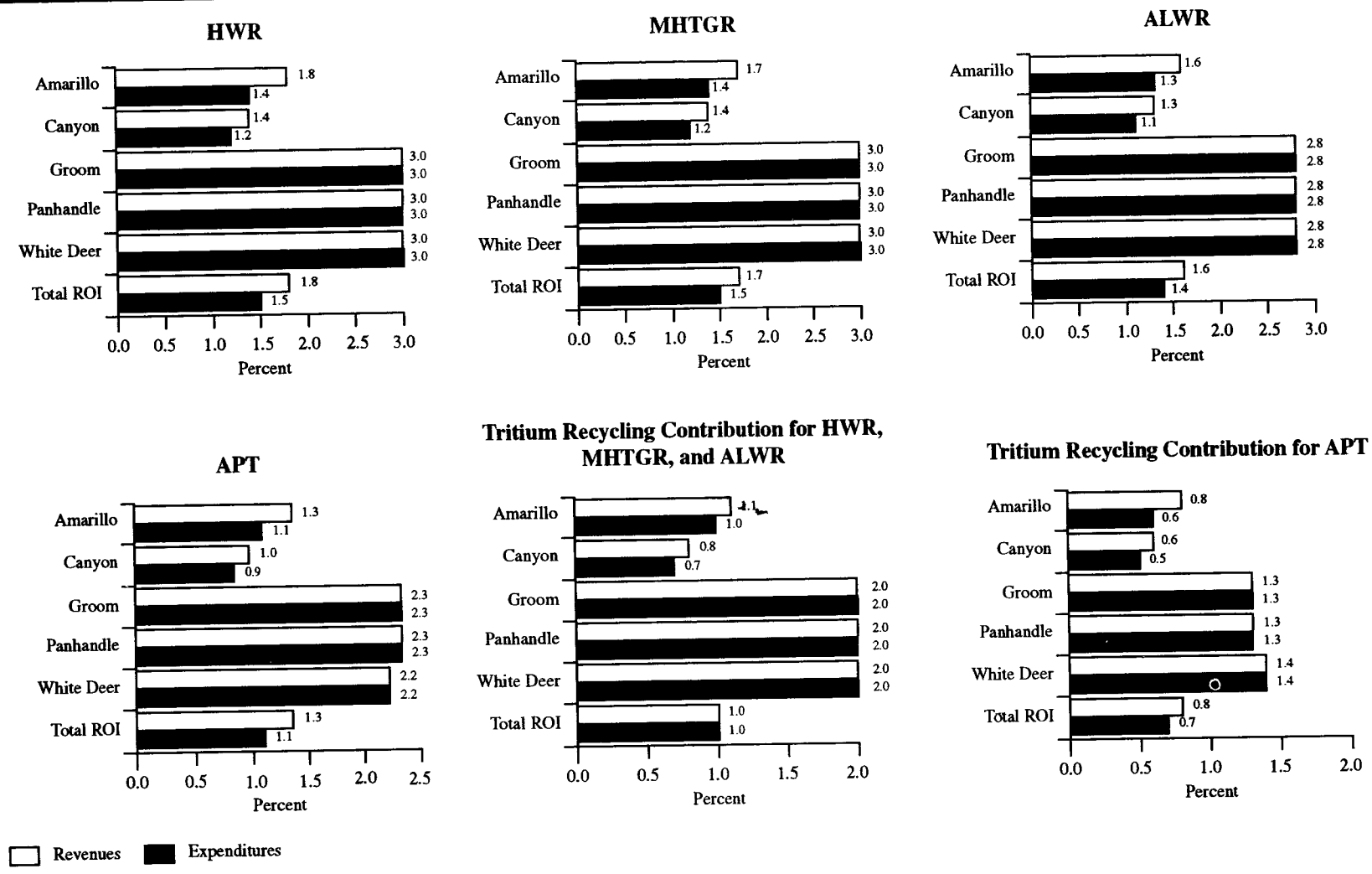
**FIGURE 4.5.3.8–6.—*County and City Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2010.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of school district revenues and expenditures, see appendix table D.3–70.

Source: Appendix table D.3–70.

**FIGURE 4.5.3.8–7.—*School District Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling for Pantex Plant, 2005.***




Note: Tritium supply technologies include recycling. To calculate tritium supply only, subtract tritium recycling contribution. For a complete breakdown of school district revenues and expenditures, see appendix table D.3–71.

Source: Appendix table D.3–71.

**FIGURE 4.5.3.8–8.—*School District Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling at Pantex Plant, 2010.***

facilities. Appendix tables D.3-64 and D.3-66 present the revenue and expenditure changes of the ROI local governments over No Action during peak construction of the tritium supply technology only.

Operation. The operation phase of the tritium supply technology only would affect the public finances of counties, cities, and school districts in the ROI, but these effects would be less than those occurring with the recycling facilities. Appendix tables D.3–65 and D.3–67 present the effects that operation would have on these local jurisdictions in the year 2010. During the years 2010 to 2020, annual growth in revenues and expenditures would be flat. No Action local government revenues and expenditures would increase at an average annual rate of less than 1 percent.

*Less Than Baseline Operations.* The fiscal benefits that local jurisdictions would accrue from the location of a tritium supply technology alone or collocated with recycling would be the same or less if the tritium supply technology were operated at less than baseline tritium requirements.

Construction. Increases in local jurisdictions' revenues and expenditures would be the same as those given in figures 4.5.3.8–5 and 4.5.3.8–7 if the HWR, ALWR, or MHTGR were built. If the Phased APT were constructed, the effects would peak in the year 2003 instead of 2005, and the annual average increases would be lower. Appendix tables D.3–64 through D.3–67 give the revenue and expenditure changes as a result of constructing the Phased APT for all ROI jurisdictions. Revenue and expenditure changes resulting from the construction of the Phased APT with tritium recycling are presented in appendix tables D.3–68 through D.3–71.

Operation. Operation of the HWR, MHTGR, ALWR, and Phased APT at less than baseline tritium requirements would have the same effects on local jurisdictions' finances as those presented in figures 4.5.3.8–6 and 4.5.3.8–8.

**Potential Mitigation Measures.** Adding new missions to Pantex would create new jobs and generally benefit the local economy through increased earnings in the ROI. Some mitigation measures may be required, such as Federal aid to local school districts where additional school age children would attend as a result of the proposed action. These new missions at Pantex would increase population and the demand for additional housing units. Temporary housing units and mobile homes would help to alleviate the demand for new housing during the construction phase of the proposed action. Generally, construction would be phased over a period of 5 to 9 years with peak construction occurring in the year 2005. Phasing the start of operation employment and training between 2005 and 2010 would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

**Local Transportation.** The following is a description of the effects on local transportation resulting from locating new missions at Pantex. Construction and operation of a tritium supply technology and recycling facility are expected to increase traffic volume and flow on site access routes.

*No Action.* Under No Action, the worker population at Pantex would not increase. Therefore, any increases in traffic would not be the result of DOE-related activities at Pantex. Access to the 4-lane U.S. Highway 60 is 2 miles from the nearest access gate. The nearest interstate highway is 7 miles via 2- and 4-lane roads that pass through rural areas. The ROI could be affected by winter weather conditions that could restrict access to the plant. Traffic conditions on site access roads would remain as described in section 4.5.2.8.

*Tritium Supply and Recycling.* The proposed action would result in increases, depending on the tritium supply technology, of worker population at the site. Traffic conditions on site access roads leading to and from Pantex would worsen due to increased traffic volume and flow. Locating the MHTGR or ALWR at Pantex would have the greatest effect on traffic volume and flow.

*Tritium Supply Alone.* Locating a tritium supply technology without the recycling facility at Pantex would result in increased worker population and traffic. However, the effects on traffic would be less than those from siting the tritium recycling facility with any one of the supply technologies.

*Less Than Baseline Operations.* The effects on traffic volume and flow would be the same whether or

not the HWR, MHTGR or ALWR were operated at baseline or less than baseline tritium requirements. Construction of the Phased APT would increase traffic volume and flow during the construction phase but less than for the Full APT.

*Potential Mitigation Measures.* Mitigation of traffic conditions may be necessary due to the proposed action at Pantex. Potential mitigation of impacts to the local transportation network could include widening and extension of Farm-to-Market Road 683, the primary access route to Pantex, as well as possible realignment of roadways and construction of interchanges at U.S. Highway 60 roadway intersections overburdened by increased vehicle traffic and congestion (PX DOT 1991a).

### 4.5.3.9 *Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents*

This section describes the impacts of radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or accidents at facilities involved with tritium supply technologies and recycling facilities at Pantex. The section first describes the impacts from normal operations followed by a description of impacts from facility accidents.

During normal operation at Pantex, all tritium supply technologies and recycling facilities would result in impacts that are within regulatory limits. The risk of adverse health effects to the public and to workers would be small.

For facility accident impacts, the results indicate that for all technologies, the risk of fatal cancers (taking into account both the probability of the accident and its consequences), from an accidental release of radioactive or hazardous chemical substance at Pantex is low when compared to fatal cancers from all causes, even for a severe accident.

The impact methodology is described in section 4.1.9. Summaries of the radiological and chemical impacts associated with normal operation are presented in tables 4.5.3.9–1 and 4.5.3.9–2, respectively. Summaries of impacts associated with postulated accidents are given in tables 4.5.3.9–3 and 4.5.3.9–4. Detailed results are presented in appendix E for normal operation and in appendix F for accidents.

**Normal Operation.**

*No Action.* The current missions at Pantex are described in section 3.3.4. Site representation has identified facilities that will continue to operate and others, if any, that will become operational by 2010. Based on that information, the radiological releases for 2010 and beyond were developed and used in the impact assessments.

Radiological Impacts. As shown in table 4.5.3.9–1, No Action would result in a calculated annual dose of $1.3 \times 10^{-3}$ mrem to the maximally exposed member of the public, which projects to an estimated fatal cancer risk of $2.6 \times 10^{-8}$ from 40 years of total site operation. This annual dose is within radiological limits and is $3.8 \times 10^{-4}$ percent of the natural background radiation received by the average person near Pantex.

The population dose from total site operation in the year 2030 was calculated to be $5.7 \times 10^{-4}$ person-rem, which projects to an estimated $1.1 \times 10^{-5}$ fatal cancers over 40 years of total site operation. This population dose would be approximately $5.7 \times 10^{-7}$ percent of the annual dose received by the surrounding population from natural background radiation.

The annual average dose to a site worker from No Action would be 15 mrem, which projects to an estimated fatal cancer risk of $2.4 \times 10^{-4}$ from 40 years of site operation. The annual dose to the total site workforce would be 37 person-rem, which projects to in an estimated 0.59 fatal cancers from 40 years of total site operation. The estimated worker doses are based on the measured annual average worker doses at Pantex from 1989 to 1992 and the projected employment for the year 2010.

Hazardous Chemical Impacts. As shown in table 4.5.3.9–2, No Action would result in a calculated HI of 0.030 and a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The worker HI and cancer risk were calculated to be 0.49 and 0.01, respectively. The HI values are both within the acceptable regulatory health limits; however, the cancer risks for the maximally exposed member of the public and the worker onsite at Pantex are in excess of the typical threshold of regulatory concern

**TABLE 4.5.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Pantex Plant***

| Affected Environment | No Action | Tritium Supply Technologies and Recycling | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | HWR[a] | MHTGR[a] | ALWR[a] | | APT[a] | | | Tritium Recycling |
| | | | | Large | Small | Full | | Phased | |
| | | | | | | Helium-3 Target System | SILC Target System | Helium-3 Target System | |
| **Maximally Exposed Individual (Public)[b]** | | | | | | | | | |
| Dose[c] (mrem/yr) | $1.3\times10^{-3}$ | 3.8 | 2.4 | 4.9 | 4.8 | 1.4 | 2.1 | 1.4 | 1.4 |
| Percent of natural background[b] | $3.8\times10^{-4}$ | 1.1 | 0.7 | 1.4 | 1.4 | 0.42 | 0.61 | 0.42 | 0.40 |
| 40-Year Fatal cancer risk | $2.6\times10^{-8}$ | $7.6\times10^{-5}$ | $4.8\times10^{-5}$ | $9.8\times10^{-5}$ | $9.6\times10^{-5}$ | $2.9\times10^{-5}$ | $4.2\times10^{-5}$ | $2.9\times10^{-5}$ | $2.8\times10^{-5}$ |
| **Population Within 50 Miles** | | | | | | | | | |
| ***Year 2030*** | | | | | | | | | |
| Dose (person-rem) | $5.7\times10^{-4}$ | 28 | 16 | 37 | 35 | 9.2 | 14 | 9.2 | 9.0 |
| Percent of natural background[c] | $5.7\times10^{-7}$ | 0.028 | 0.016 | 0.037 | 0.035 | $9.3\times10^{-3}$ | 0.014 | $9.3\times10^{-3}$ | $9.0\times10^{-3}$ |
| 40-Year Fatal cancers | $1.1\times10^{-5}$ | 0.55 | 0.31 | 0.73 | 0.69 | 0.18 | 0.27 | 0.18 | 0.18 |
| **Worker Onsite** | | | | | | | | | |
| Average worker dose (mrem/yr)[d] | 15 | 25 | 22 | 68 | 46 | 29 | 29 | 29 | 4 |
| 40-Year Fatal cancer risk | $2.4\times10^{-4}$ | $4.0\times10^{-4}$ | $3.5\times10^{-4}$ | $1.1\times10^{-3}$ | $7.4\times10^{-4}$ | $4.6\times10^{-4}$ | $4.6\times10^{-4}$ | $4.6\times10^{-4}$ | $6.4\times10^{-5}$ |
| Total workforce dose (person-rem/yr) | 37 | 78 | 67 | 210 | 140 | 90 | 91 | 90 | 1.6 |
| 40-Year Fatal cancers | 0.59 | 1.2 | 1.1 | 3.3 | 2.2 | 1.4 | 1.5 | 1.4 | 0.026 |

[a] Includes impacts from No Action facilities.

[b] The location of the maximally exposed individual varies depending on the tritium supply technology.

[c] Natural background levels: to the average individual is 346 mrem per year; to the population in the year 2030 is 99,470 person-rem.

[d] The applicable radiological limits for an individual member of the public from site operations are 10 mrem per year for the air pathways and 100 mrem per year from all pathways combined (DOE Order 5400.5). The radiological limit for an individual worker is 5,000 mrem/yr (40 CFR 835).

Note: SILC - spallation-induced lithium conversion.

Note: Model results. See appendix sections E.2.2, E.2.7, and E.2.7.2.

of $1x10^{-6}$. For details on the derivation of these HIs and cancer risks, see appendix table E.3.4–22 and summary table E.3.4–27.

*Tritium Supply and Recycling.* There will be no radiological releases during the construction of either new tritium recycling facilities or new facilities that are associated with all tritium supply technologies under consideration.

Limited hazardous chemical releases are anticipated as a result of construction activities. However, their concentration will be well within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be both radiological and hazardous chemical releases to the environment plus direct in-plant exposures. The impacts from radiological and hazardous chemicals from each tritium supply technology considered are the summations of the impacts from the various facilities in operation for that technology. The resulting doses and potential health effects to the public and workers from each alternative are described below.

Radiological Impacts. Radiological impacts to the public resulting from normal operations of various tritium supply technologies and recycling facilities at Pantex are listed in table 4.5.3.9–1. The supporting analysis is provided in appendix section E.2.7.2.

The doses to the maximally exposed member of the public from annual site operations at Pantex range from 1.4 mrem for both the APT with the helium-3 target option and the Phased APT to 4.9 mrem for the Large ALWR. From 40 years of operation, the corresponding risks of fatal cancer to this individual would range from $2.9x10^{-5}$ to $9.8x10^{-5}$. As a result of total site operations in the year 2030, the population doses would range from 9.2 person-rem for the same two APT technologies to 37 person-rem for the Large ALWR. The corresponding numbers of fatal cancers in this population from 40 years of operation would range from 0.18 to 0.73.

The annual dose to the total site workforce would range from 67 person-rem for the MHTGR to 210 person-rem for the Large ALWR. The corresponding annual average doses to a site worker would be 22 mrem for the MHTGR and 68 mrem for the Large ALWR. The risks and numbers of fatal cancers among workers from 40 years of operation are included in table 4.5.3.9–1.

Based on the radiological impacts associated with normal operation, as described above, all of the tritium supply technologies and recycling facilities are acceptable for siting at Pantex. All resulting doses are within radiological limits and are below levels of natural background radiation.

**TABLE 4.5.3.9–2.—*Potential Hazardous Chemical Impacts to the Public and Workers Resulting from Normal Operation at Pantex Plant***

| | | Tritium Supply Technologies and Recycling | | | | |
|---|---|---|---|---|---|---|
| **Health Impact** | **No Action** | **HWR[a,b]** | **MHTGR[a,b]** | **ALWR[a,b]** | **APT[a,b]** | **Tritium Recycling** |
| **Maximally Exposed Individual (Public)** | | | | | | |
| Hazard Index | 0.030 | 0.031 | 0.030 | 0.034 | 0.030 | $3.2x10^{-3}$ |
| Cancer risk | $1.1x10^{-5}$ | $1.1x10^{-5}$ | $1.1x10^{-5}$ | $1.1x10^{-5}$ | $1.1x10^{-5}$ | 0 |
| **Worker Onsite[c]** | | | | | | |
| Hazard Index | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 | $1.6x10^{-5}$ |
| Cancer risk | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0 |

[a] Includes impacts from No Action.

[b] To determine the contribution from any of the tritium supply technologies, subtract the tritium recycling values for the hazard Index or the cancer risk, respectively.

[c] The Hazard Index for the onsite worker is computed by using the permissible exposure level as the denominator rather than the reference concentration which is used for the maximally exposed member of the public (appendix E).

Note: Model results. See appendix table E.3.4–28.

*Tritium Supply Alone*

Radiological Impacts. If the tritium recycling processes were not collocated with the tritium supply, the annual dose to the maximally exposed individual will decrease by 1.4 mrem, which is 0.40 percent of the dose from natural background radiation received by the average person near Pantex. The estimated risk of fatal cancer to this individual would decrease by $2.8 \times 10^{-5}$ over 40 years of total site operation. Not collocating the tritium recycling processes at Pantex would result in a decrease of 9.0 person-rem to the population within 50 miles in year 2030, and 0.18 fewer fatal cancers over 40 years of operation.

If the tritium recycling processes were not collocated with the tritium supply, the average annual dose to an onsite worker would decrease by 4 mrem per year. In addition, the estimated risk of fatal cancer to this worker would decrease by $6.4 \times 10^{-5}$ over 40 years of site operation. The total annual workforce dose would decrease by 1.6 person-rem, resulting in 0.026 fewer fatal cancers over the 40 years.

Hazardous Chemical Impacts. If the tritium recycling processes are eliminated from all of the supply technologies at Pantex, the cancer risk would remain at $1.1 \times 10^{-5}$. The HIs for the public would be reduced by approximately 10 percent for any of the supply technologies. The worker HIs would be almost unchanged (i.e., 0.003 percent reduction) and the cancer risk to workers would remain at 0.01 (i.e., $10^{-2}$). Based on the hazardous chemical impacts, the HIs are within regulatory limits, but the cancer risks for both the public and workers exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. Both public and worker cancer risk exceed the typical threshold of regulatory concern at 1.10-6. The HI values are within acceptable regulatory health limits. For details on the derivation of these HIs and cancer risks, see appendix E, tables E.3.4–24 through E.3.4–26 and summary table E.3.4–28.

If the tritium recycling processes were not collocated with the supply technologies, the cancer risks to the public and the worker remain the same at $1.1 \times 10^{-5}$ and 0.010 because the entire cancer risks is due to the No Action contribution. The HIs for the public would be reduced by 10.6 percent (APT) to 9.3 percent (ALWR) and the HIs for workers would be virtually unaffected by a 0.003 percent reduction for all technologies. Although the HI values for the public and worker are acceptable, the cancer risks exceed the threshold of regulatory concern of $1 \times 10^{-6}$.

*Less Than Baseline Operations.* The normal operation radiological impacts for the HWR operating at reduced tritium production capacity to meet a less than baseline operations requirement would be proportional to the level of operation (approximately 50 percent of baseline). The MHTGR or ALWR normal operation radiological impacts would not change because the reactor would maintain power requirements to produce steam or electricity.

The Phased APT is already less than the baseline tritium requirement and thus the impacts are as presently given in this PEIS.

*Potential Mitigation Measures.* Radioactive and hazardous chemical airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated and robotic production methods are examples of techniques that are being developed which could reduce worker exposure. Substitution of less toxic/noncancer causing solvents would result in reductions of the HI and possible complete elimination of the cancer risk.

**Facility Accidents.**

*No Action.* Under No Action, the risk of accidents at Pantex would be unchanged from that reported in safety analysis reports for existing facilities.

*Tritium Supply and Recycling.* The proposed action at Pantex has the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents have been assessed for each tritium supply and recycling facilities at Pantex and are summarized in this section and described in more detail in appendix F. The methodology used in the assessment is described in section 4.1.9.

The potential impacts from accidents, ranging from high-consequence/low-probability to low-consequence/high-probability events, have been evaluated in terms of the number of cancer fatalities that may result. The risk of cancer fatalities has also been evaluated to provide an overall measure of accident impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities).

The analyses of accidents for the tritium supply and recycling facilities at Pantex indicate that, for the high consequence accident, the risk of cancer fatalities to the public within 50 miles of the site would be $5.7 \times 10^{-6}$ cancer fatalities per year (table 4.5.3.9–3). This accident risk, which corresponds with the ALWR, is low when compared to the risk of cancer fatalities each year to the same population from all other causes.

Details on the range of accidents for the tritium supply technologies and recycling facilities at Pantex are presented in appendix F. Each of the technologies has been analyzed from the standpoint of identifying the consequences of design basis/operational accidents (using the GENII computer code) and beyond design basis, or severe accidents (using the MACCS computer code). The severe accident consequences are shown in table 4.5.3.9–3 for each technology. The table also shows the consequences of each accident for the population and for an individual located at the site boundary during the accident. The results of the analysis indicate that the ALWR has the highest severe accident consequence. The technology with the lowest accident consequence is the APT. The tritium recycling facility is common to all tritium supply technologies but, except for the APT, the consequences are dominated by reactor accidents. The tritium extraction accident dominates the accelerator accidents.

Figure 4.5.3.9–1 shows the number of latent cancer fatalities that may result for each technology, including tritium extraction and recycling, if a high consequence accident were to occur. Specifically, each curve in the figure shows the conditional probability (vertical axis) that the number of cancer fatalities (horizontal axis) will be exceeded if the accident occurred. The curves do not reflect the probability of the accident.

The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be reduced; recreational areas may be closed; industrial parks may suffer economic losses; historical sites may have to be closed to visitors; and the endangered species may move closer to extinction. In the region of Pantex, the natural background level of radiation (excluding radon) is 107 mrem per year. For a hypothetical design basis accidental release, the radiation levels exceeding 107 mrem per year extends beyond the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $9.3 \times 10^{7}$ square meters (22,980 acres).

*Tritium Supply Alone.* The analyses of reasonably foreseeable high consequence accidents for the tritium supply facilities at Pantex are presented below.

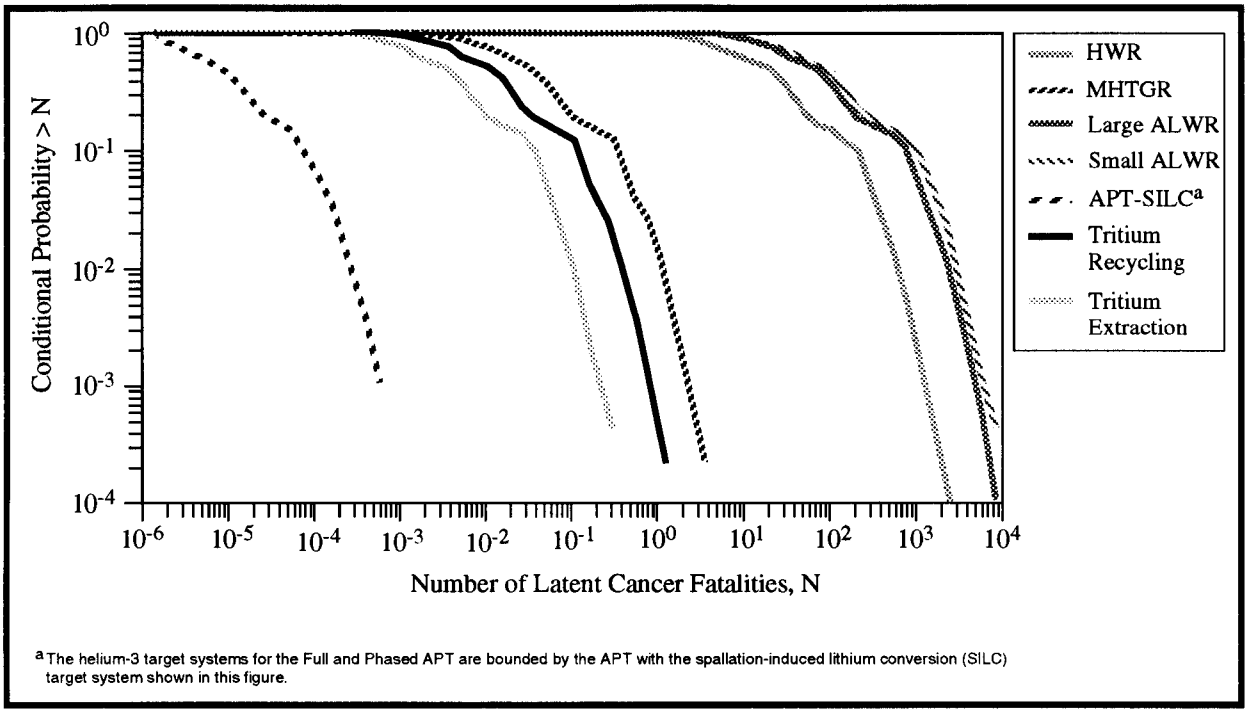
Heavy Water Reactor. A set of accident sequences with a release category in which there is a reactor isolation failure with containment spray failed was postulated as a high consequence accident for the HWR. In the event that this accident were to occur, there would be an estimated 64 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of 0.01 to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is $3.2 \times 10^{-6}$ cancer fatalities per year (table 4.5.3.9–3).

Modular High Temperature Gas-Cooled Reactor. A set of accident sequences with a release category in which there is a depressurized conduction cooldown without the reactor cavity cooling system functioning was postulated. This would be a high consequence accident for the MHTGR. In the event that this accident were to occur, there would be an estimated 0.12 cancer fatalities in the population within 50 miles and an increased likelihood of cancer of $2.2 \times 10^{-5}$ to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is less

**TABLE 4.5.3.9–3.—*Tritium Supply Technologies and Recycling High Consequence/Low Probability Radioactive Release Accidents and Consequences at Pantex Plant***

| Parameter | Tritium Supply Technologies | | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
|---|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | | |
| | | | Large | Small | Full/Phased | Phased | | |
| | | | | | Helium-3 Target System[f,g] | SILC Target System[h,i] | | |
| **Accident** | | | | | | | | |
| Frequency (per year) | $5.0\times10^{-8}$ | $6.0\times10^{-8}$ | $2.0\times10^{-8}$ | $2.0\times10^{-8}$ | $1.0\times10^{-4}$ | $1.0\times10^{-4}$ | $1.0\times10^{-6}$ | $1.0\times10^{-6}$ |
| **Consequence** | | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | | |
| Dose (rem) | 426 | 0.82 | $1.7\times10^{3}$ | $1.7\times10^{3}$ | $1.7\times10^{-4}$ | $1.6\times10^{-3}$ | 0.19 | 0.66 |
| Cancer fatalities | 0.012 | $2.2\times10^{-5}$ | 0.044 | 0.05 | $3.5\times10^{-9}$ | $2.6\times10^{-8}$ | $4.3\times10^{-6}$ | $1.5\times10^{-5}$ |
| Risk (cancer fatalities per year) | $6.0\times10^{-10}$ | $1.3\times10^{-12}$ | $8.7\times10^{-10}$ | $1.0\times10^{-9}$ | $3.5\times10^{-13}$ | $2.6\times10^{-12}$ | $4.3\times10^{-11}$ | $1.5\times10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | | |
| Dose (person-rem) | $1.3\times10^{5}$ | 236 | $4.8\times10^{5}$ | $5.7\times10^{5}$ | 0.022 | 0.15 | 28 | 96 |
| Cancer fatalities | 64.4 | 0.12 | 238 | 283 | $1.1\times10^{-5}$ | $7.5\times10^{-5}$ | 0.014 | 0.048 |
| Risk (cancer fatalities per year) | $3.2\times10^{-6}$ | $7.1\times10^{-9}$ | $4.8\times10^{-6}$ | $5.7\times10^{-6}$ | $1.1\times10^{-9}$ | $7.5\times10^{-9}$ | $1.4\times10^{-8}$ | $4.8\times10^{-8}$ |

[a] For detailed HWR accident discussion see appendix section F.2.1.1.
[b] For detailed MHTGR accident discussion see appendix section F.2.1.2.
[c] For detailed ALWR accident discussion see appendix section F.2.1.3.
[d] For detailed tritium target extraction facility discussion, see appendix section F.2.1.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.
[e] For detailed tritium recycling facility discussion, see appendix section F.2.3.
[f] For detailed APT with helium-3 target system discussion, see appendix section F.2.1.4.2.
[g] Analysis postulated the total failure of the active emergency cooling system and the loss of the heat sink.
[h] For detailed APT with spallation-induced lithium conversion target system discussion, see appendix section F.2.1.4.3.
[i] Analysis postulated successful beam trip with the total failure of the active emergency cooling system.
Note: SILC - spallation-induced lithium conversion.
Note: Model results.




[a] The helium-3 target systems for the Full and Phased APT are bounded by the APT with the spallation-induced lithium conversion (SILC) target system shown in this figure.

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**FIGURE 4.5.3.9–1.—*High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Functions for Tritium Supply and Recycling Severe Accidents at Pantex Plant.***

than $7.1 \times 10^{-9}$ cancer fatalities per year (table 4.5.3.9–3).

Advanced Light Water Reactor. A range of accident sequences with various release categories was analyzed for the ALWR. One release category for a Large ALWR and one for a Small ALWR were postulated and were selected to represent the accident consequences for an ALWR (appendix section F.2.1.3). In the event that such an accident were to occur, there would be an estimated 238 cancer fatalities for the Large ALWR, and 283 cancer fatalities for the Small ALWR, in the population within 50 miles and an increased likelihood of cancer of 0.04 for the Large and 0.05 for the Small ALWR to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is $4.8 \times 10^{-6}$ cancer fatalities per year for the Large ALWR, and $5.7 \times 10^{-6}$ cancer fatalities per year for the Small ALWR (table 4.5.3.9–3).

Accelerator Production of Tritium with Helium-3 Target System. The large break loss of coolant accident with the total loss of the active emergency cooling system and the heat sink was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $1.1 \times 10^{-5}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $3.5 \times 10^{-9}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $1.1 \times 10^{-9}$ cancer fatalities per year (table 4.5.3.9–3).

Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System. The large break loss of coolant accident with a successful beam trip and the total loss of the active emergency cooling system was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $7.5 \times 10^{-5}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $2.6 \times 10^{-8}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $7.5 \times 10^{-9}$ cancer fatalities per year (table 4.5.3.9–3).

*Tritium Extraction and Recycling.* The tritium extraction facility is required to support all tritium supply technologies except the APT technology with the helium-3 target system. The tritium recycling facility is required to support all tritium supply technologies. The analyses of postulated high consequence accidents for the tritium extraction and recycling facilities at Pantex are presented below.

Tritium Target Extraction Facility. An earthquake and release of process vessel tritium inventory was postulated as the high consequence accident. The consequences and risk of any accident associated with the accelerator beam and target would be much lower. In the event that this accident were to occur, there would be an estimated 0.014 cancer fatalities in the population within 50 miles and an increased likelihood of cancer $4.3 \times 10^{-6}$ to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is on the order $1.4 \times 10^{-8}$ cancer fatalities per year (table 4.5.3.9–3).

Tritium Recycling Facility. An earthquake induced leak/ignition and fire in the unloading station carousel reservoir was postulated as the high consequence accident for a tritium recycling facility. In the event that this accident were to occur, there would be an estimated 0.048 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.5 \times 10^{-5}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of accident into account, is on the order of $4.8 \times 10^{-8}$ cancer fatalities per year (table 4.5.3.9–3).

For comparison purposes with high consequence tritium supply facility accidents, including extraction and recycling, for the same total population of 287,000 in the year 2050 within 50 miles of the site, there is a risk of 574 cancer fatalities per year from all other natural causes.

The analysis of facility accidents for tritium supply at Pantex shows that for high consequence accidents analyzed using the MACCS computer code, the ALWR has the highest consequences and risk and the APT has the lowest consequences and risk. The risk of accidents for any of the tritium supply technologies, tritium extraction, and tritium recycling facilities common to all technologies is low when compared to the human risk of cancer fatalities from all other causes.

The consequences of operational basis or design basis accidents for the tritium extraction and recycling facilities at Pantex are shown in table 4.5.3.9–4. The results in table 4.5.3.9–4 should not be compared with the severe accident analysis results in table 4.5.3.9–3 because different computer codes using different calculational approaches were used.

*Less Than Baseline Operations.* Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the HWR unless the baseline HWR core design was downsized. The baseline HWR configuration would adjust to the reduced target throughput requirements by reducing the time that the reactor is required to operation at 100 percent power. It is not anticipated that the overall risk from operating the reactor in this mode would decrease significantly. Accident analyses have not been performed to address accident sequences and initiating events when the reactor is in the cold shutdown mode. In addition, operator error has a significant effect on facility risk, and if the reactor is shutdown a high percentage of the time, operator error may actually increase when the reactor is at power.

Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the ALWR. The reactor surplus capacity would be used to generate steam for electric power production.

Less than baseline tritium operation would have no change to the MHTGR accident analyses because the analyses assumed that only one of the modules would be involved in the accident.

Less than baseline tritium operation would have no significant change to the APT accident analyses consequences. The accident consequences for Full and Phased APT accident with low to moderate consequences were negligible. For the beyond design basis accident, there was no difference in the Full and the Phased accident consequences. Review of the source terms for the Full and the Phased APT indicated that the tritium component of the source term is identical for both accidents. Review of the MACCS computer code output data for each accident

**TABLE 4.5.3.9–4.—*Tritium Supply Technologies and Recycling Low to Moderate Consequence Radioactive Release Accidents and Consequences at Pantex Plant***

| Parameter | Tritium Supply Technologies | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility[e] |
|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR/Large[c] | ALWR/Small | APT SILC Target System[f] | | |
| **Accident** | | | | | | | |
| Description | Fuel Assembly failure during charge and discharge operations | Large break in primary system piping | Large break loss of coolant accident | Large break loss of coolant accident | Large break loss of coolant accident[g] | Deflagration[h] | Hydride Bed Rupture |
| Frequency (per Year) | 0.01 | 0.01 | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $2.0 \times 10^{-5}$ | $2.0 \times 10^{-4}$ |
| **Consequence** | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | |
| Dose (rem) | 0.015 | 0.016 | 3.9 | 0.18 | Negligible | 0.077 | $3.3 \times 10^{-4}$ |
| Cancer fatalities | $7.4 \times 10^{-6}$ | $8.1 \times 10^{-6}$ | $2.0 \times 10^{-3}$ | $8.9 \times 10^{-5}$ | Negligible | $3.9 \times 10^{-5}$ | $1.7 \times 10^{-7}$ |
| Risk (cancer fatalities per year) | $7.4 \times 10^{-8}$ | $8.1 \times 10^{-8}$ | $2.0 \times 10^{-6}$ | $8.9 \times 10^{-8}$ | Negligible | $7.8 \times 10^{-10}$ | $3.4 \times 10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | |
| Dose (person-rem) | 52 | 68 | $1.6 \times 10^{4}$ | 730 | Negligible | 320 | 1.4 |
| Cancer fatalities | 0.026 | 0.034 | 8.0 | 0.36 | Negligible | 0.16 | $7.0 \times 10^{-4}$ |
| Risk (cancer fatalities per year) | $2.6 \times 10^{-4}$ | $3.4 \times 10^{-4}$ | $8.0 \times 10^{-3}$ | $3.6 \times 10^{-4}$ | Negligible | $3.2 \times 10^{-6}$ | $1.4 \times 10^{-7}$ |

[a] For detailed HWR accident discussion see appendix section F.2.2.1.

[b] For detailed MHTGR accident discussion see appendix section F.2.2.2.

[c] For detailed ALWR accident discussion see appendix section F.2.2.3.

[d] For detailed tritium target extraction facility discussion, see appendix section F.2.2.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.

[e] For detailed tritium recycling facility discussion, see appendix section F.2.4.

[f] The APT with helium-3 target system bounding low to moderate consequence accident consequences are bounded by the APT with spallation-induced lithium conversion target system which are nil. For detailed APT discussion, see appendix section F.2.2.4.

[g] Analysis postulated all plant protection systems functioned as designed.

[h] Intense rapid burning.

Note: SILC - spallation-induced lithium conversion.

Note: Model results.

analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results is negligible.

*Potential Mitigation Measures.* The accidents postulated for tritium supply technologies and recycling facilities are based on operations and safety analyses that have been performed at similar facilities. One of the major design goals for tritium supply and recycling facilities is to achieve a reduced risk to facility personnel and to public health and safety to as low as reasonably achievable.

Worker exposures that may result from the accidental release of radioactive material will be minimized through design features and administrative procedures that will be defined in conjunction with the facility design process. The radiological impacts to workers from accidents could not be estimated for this PEIS because the facility design information needed to support the estimate has not yet been developed. The impacts on workers from accidents will be analyzed as part of subsequent project-specific NEPA documentation and in detailed safety analysis documentation that are prepared in conjunction with the facility design process.

The tritium supply and recycling facilities would be designed to comply with current Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide facilities that are highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, high wind, as well as credible events as appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity for containing materials. Because of the proximity of Pantex to the Amarillo airport, special provisions may be necessary in the design to harden the facility against the potential forces of an aircraft crash into the facility.

The tritium supply and recycling facilities would be designed to resist the effects of severe natural phenomena as well as the effects of man-made threats to its continuing structural integrity. It also would be designed to provide containment of the tritium inventory at all times through the use of multiple, high quality confinement barriers to prevent the accidental release of tritium to the environment. It also would be designed to produce a lower quantity of waste materials as compared to the tritium facilities of the existing weapons complex.

In addition, DOE orders specify the requirements for emergency preparedness at DOE facilities. Pantex has comprehensive emergency plans to protect life and property within the facility and the health and welfare of surrounding areas. The emergency plans would be revised to incorporate future DOE requirements and expanded to incorporate the addition of tritium supply and recycling facilities to Pantex. See section 4.5.2.9 for emergency preparedness and emergency plan details at Pantex.

#### 4.5.3.10 *Waste Management*

Construction and operation of tritium and recycling facilities would impact existing Pantex waste management operations, increasing the generation of low-level, mixed low-level, hazardous, and nonhazardous waste, and initiating the generation of spent nuclear fuel. There are no high-level or TRU wastes associated with the proposed action. All reactor technologies would provide treatment and storage of spent fuel for the life of the facility. Spent nuclear fuel would be managed in accordance with DOE's decisions identified in the ROD after the completion of the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS.* Siting tritium supply and recycling facilities at Pantex would involve the construction of new treatment and staging facilities for solid LLW generation for all the technologies. New liquid LLW treatment facilities for the HWR, MHTGR, and ALWR would be necessary. Due to the increased generation of solid mixed LLW, new or expanded storage facilities would be necessary for the HWR and ALWR.

All the technologies would generate enough solid sanitary waste to shorten the planned lifetime of the city of Amarillo landfill or require its expansion. All technologies would require additional or expansion of existing treatment facilities for liquid sanitary waste. This section provides a description of waste generation, treatment, storage, and disposal requirements of the tritium supply and recycling facilities and the potential impacts on waste management at Pantex. Because Pantex does not currently dispose

of radioactive waste onsite, the incremental increase in shipments of LLW at Pantex to NTS is estimated. The incremental increased risk due to these shipments is analyzed in section 4.7.

**No Action.** Under No Action, low-level, mixed low-level, hazardous, and nonhazardous waste would continue to be managed at Pantex from the missions described in section 3.3.4. Table 4.5.3.10–1 lists the projected waste generation rates, and treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1992 environmental data with appropriate adjustments made for those changing operational requirements where the volume of wastes generated are identifiable. The projection does not include wastes from future, yet uncharacterized, environmental restoration activities. Pantex might also store, over the long term, certain quantities of sealed plutonium pits; however, no impact on waste management is expected since such storage generates minimal additional waste.

Pantex's assembly/disassembly and high explosives programs would continue to generate low-level, mixed low-level, and hazardous waste. Compactible components of solid LLW would continue to be processed at the onsite solid waste compaction facility. Mixed waste would be treated and disposed of according to the Pantex Site Treatment Plan, which is currently being developed pursuant to the *Federal Facility Compliance Act* of 1992. Although the predominant workload in 1992 was disassembly operations, the activity levels were assumed to be representative of projected workload levels that characterize No Action operations. It is expected that through waste minimization efforts, generation rates would decrease.

**Tritium Supply and Recycling.** Tritium supply and recycling facilities that would support the nuclear weapons stockpile requirements (both new and existing facilities) would treat and package all waste generated in support of this activity into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2. The resultant waste effluents are shown in section 3.4. Waste generated during construction would consist of wastewater, solid nonhazardous, and hazardous waste. The nonhazardous wastes would be recycled or disposed of as part of the construction project by the contractor except for solid sanitary waste, which would be sent offsite to the city of Amarillo sanitary/industrial landfill. The hazardous wastes would be shipped offsite to a RCRA-permitted treatment and disposal facility. Operation of the three reactor-based tritium supply technologies and recycling facilities would generate spent fuel, and all four technologies would generate low-level, mixed low-level, hazardous, and nonhazardous wastes. The volume of the waste streams from tritium supply would vary according to the tritium supply technology chosen. Table 4.5.3.10–2 lists the total estimated waste volumes projected to be generated at Pantex as a result of various tritium supply technologies and recycling facilities. The incremental waste volumes from the tritium supply technologies that were added to the No Action projection can be found in appendix section A.2. Table 4.5.3.10–3 lists potential waste management impacts at Pantex at the time of initial operation of the tritium facilities.

Spent nuclear fuel storage for the life of the reactors is provided for in the reactor designs (appendix section A.2.1). The interim management of spent nuclear fuel (pending the availability of a geologic repository) would be in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. Because spent nuclear fuel reprocessing is not planned, no HLW would be generated. Without plutonium production, no TRU waste would be generated. The treatment, storage, and disposal of mixed LLW would be in accordance with the Pantex Plant Site Treatment Plan, which is currently being developed pursuant to the *Federal Facility Compliance Act* of 1992. LLW would continue to be shipped to NTS for disposal. Hazardous waste would be treated, staged in new hazardous waste staging facilities, and shipped offsite to a RCRA-permitted disposal facility. Nonhazardous waste would be treated utilizing current, expanded, or new facilities.

*Heavy Water Reactor.* Spent nuclear fuel would be generated at the rate of 7 $yd^3$ per year. The HWR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The liquid LLW generated from the

TABLE 4.5.3.10–1.—*Projected Waste Management Under No Action at Pantex Plant*

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Low-Level** | | | | | | | |
| Liquid | 2 (402 gal) | Solidification | 14 (3,300 GPY) | Staged for processing | 113 (23,000 gal) | NA | NA |
| Solid | 25 | Compaction | 220 | Staged for shipment | Same as liquid | Shipped offsite to NTS | NA |
| **Mixed Low-Level** | | | | | | | |
| Liquid | 2 (402 gal) | None - onsite encapsulation pending | Planned | Staged for processing | 95 (19,000 gal) | NA | NA |
| Solid | 5 | Compaction and incineration | Planned[a] | Staged for shipment | Same as liquid | Shipped offsite | NA |
| **Hazardous[b]** | | | | | | | |
| Liquid | 12 (2,420 gal) | Incineration[c] | Variable | Staged for shipment | 308[d] (62,000 gal) | Shipped offsite | NA |
| Solid | 63 | Incineration[c] | Variable | Staged for shipment | Same as liquid | Shipped offsite | NA |
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 198,000 (39,900,000 gal) | Evaporation and filtration | 1,030,000 (207,000,000 GPY) | None | NA | Lagoon and NPDES outfall (stormwater) | 1,200,000 (237,000,000 gal) |
| Solid | 734 | Compaction and incineration | 270,000 | None | NA | Landfill (offsite) | NA |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | 36,600 (7,400,000 gal) | Carbon absorption/ filtration | Included in sanitary | None | NA | Included in sanitary | Included in sanitary |
| Solid | 5,830 | Compaction and incineration | Included in sanitary | None | NA | Landfill (onsite) | Expandable |

[a] Only HE-contaminated material treatment currently exists. Estimated quantity treated in 1992 was 1.6 $yd^3$/yr.
[b] Includes PCB and asbestos-contaminated wastes and some industrial wastewater.
[c] HE-contaminated wastes only.
[d] Includes 135 $yd^3$ RCRA-permitted storage and 173 $yd^3$ for non-RCRA regulated storage.
Note: NA - not applicable
Source: DOE 1993a; PX 1993a:1; PX 1993a:2; PX Battelle 1992a; PX MH 1991c.

HWR would far exceed the limited existing treatment capability at Pantex. The HWR would have to provide a liquid radioactive waste treatment capability that would treat the liquid LLW into a solid form that would meet the waste acceptance criteria of the selected offsite LLW disposal facility. The solid LLW generated from the HWR would also exceed the Pantex capability to stage solid LLW prior to shipment to the offsite disposal facility, which is currently NTS. Expansion of existing facilities or the construction of a new facility would be examined in a site-specific NEPA analysis. Locating the HWR at Pantex would require an additional 92 shipments of solid LLW to NTS per year. Assuming a 4,000 $ft^3$/acre LLW disposal usage factor, these additional LLW shipments would require 13.5 acres of LLW disposal area at NTS. The two percent increase in liquid mixed LLW could be handled by adding the appropriate treatment capability to planned mixed waste facilities. The increase in solid mixed LLW from the HWR would require an expansion of the treatment and storage capabilities currently being studied pursuant to complying with the *Federal Facility Compliance Act* of 1992. The generation of solid hazardous waste could be handled within the existing capability at Pantex. The capacity of the staging area is approximately 300 $yd^3$ with hazardous waste continually being shipped offsite. The HWR would generate larger quantities (factor of 3) of liquid sanitary waste than currently projected for Pantex under No Action. Additional treatment facilities or expansion of existing or planned facilities would be analyzed in a site-specific NEPA analysis. The HWR would increase by a factor of 21 the quantities of solid sanitary waste for the city of Amarillo landfill as compared to No Action. This would cause an increase in the need for landfill capacity at the city of Amarillo sanitary/industrial landfill.

Siting an HWR without tritium recycling facilities at Pantex would not affect the generation of nor change the impacts from spent nuclear fuel and liquid LLW as described above and in table 4.5.3.10–3. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.5.3.10–3. The generation of solid LLW would increase by a factor of 208 over No Action and would exceed the Pantex capability to stage while awaiting shipment to NTS. However, the total number of additional shipments would be reduced to 86. Approximately 12.6 acres per year of LLW disposal would be needed at NTS to accommodate this waste. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 21 to a factor of 11; thus, proportionately decreasing the impact to the planned lifetime of the landfill.

*Modular High Temperature Gas-Cooled Reactor.* Spent nuclear fuel would be generated at the rate of 80 $yd^3$ per year. The MHTGR would be designed to provide the necessary treatment and storage of the spent nuclear fuel while awaiting final disposition. The liquid LLW generated from the MHTGR would far exceed the limited existing treatment capability at Pantex. The MHTGR would have to provide a liquid radioactive waste treatment capability that would treat the liquid LLW into a solid form that would meet the waste acceptance criteria of the selected offsite LLW disposal facility. The solid LLW generated from the MHTGR would exceed the Pantex capability (factor of 15 greater) to stage solid LLW prior to shipment to NTS. Expansion of existing facilities or the construction of a new facility would be examined in a site-specific NEPA analysis. Locating the MHTGR at Pantex would require an additional 27 shipments of solid LLW to NTS per year. The additional LLW shipments would require approximately 4 acres/year of LLW disposal at NTS. The 60-percent increase in solid mixed LLW could be handled within the existing and planned capability as currently being studied pursuant to complying with the *Federal Facility Compliance Act* of 1992. The approximate tripling of solid hazardous waste volumes due to the MHGTR could also be handled within the existing and planned capability at Pantex. The MHTGR would generate larger quantities (factor of 2 greater) of liquid sanitary wastes than is currently projected for Pantex under No Action. Additional treatment facilities or expansion of existing or planned facilities would be analyzed in a site-specific NEPA analysis. The MHTGR would increase by a factor of 21 the quantities of solid sanitary waste for the city of Amarillo landfill as compared to No Action. This would cause an increase in the need for landfill capacity at the city of Amarillo sanitary/industrial landfill.

**TABLE 4.5.3.10–2.—*Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for Tritium Supply Technologies and Recycling at Pantex Plant*[a]**

| Category | No Action ($yd^3$) | Tritium Supply and Recycling | | | | |
|---|---|---|---|---|---|---|
| | | HWR ($yd^3$) | MHTGR ($yd^3$) | ALWR/Large ($yd^3$) | ALWR/Small ($yd^3$) | APT ($yd^3$)[b] |
| **Spent Nuclear Fuel** | None | 7 | 80 | 30 | 15 | None |
| **Low-Level** | | | | | | |
| Liquid | 2 (402 gal) | 10,400 (2,100,000 gal) | 2,600 (525,000 gal) | 24,800 (5,000,000 gal) | 3,910 (790,000 gal) | 2 (402 gal) |
| Solid | 25 | 5,580 | 1,680 | 1,090 | 1,040 | 919 |
| **Mixed Low-Level** | | | | | | |
| Liquid | 2 (402 gal) | 2 (408 gal) | 2 (408 gal) | 2 (408 gal) | 2 (408 gal) | 2 (408 gal) |
| Solid | 5 | 127 | 8 | 13 | 13 | 14 |
| **Hazardous** | | | | | | |
| Liquid | 12 (2,420 gal) | 12 (2,420 gal) | 12 (2,420 gal) | 12 (2,420 gal) | 12 (2,420 gal) | 12 (2,420 gal) |
| Solid | 63 | 104 | 164 | 99 | 99 | 67 |
| **Nonhazardous (Sanitary)** | | | | | | |
| Liquid | 198,000 (39,900,000 gal) | 506,000 (102,000,000 gal) | 417,000 (84,200,000 gal) | 714,000 (144,000,000 gal) | 516,000 (104,000,000 gal) | 2,260,000 (456,000,000 gal) |
| Solid | 734 | 15,700 | 15,500 | 15,000 | 12,300 | 9,370 |
| **Nonhazardous (Other)** | | | | | | |
| Liquid | 36,600 (7,400,000 gal) | 36,600 (7,400,000 gal) | 36,600 (7,400,000 gal) | 36,600 (7,400,000 gal) | 36,600 (7,400,000 gal) | 36,600 (7,400,000 gal) |
| Solid | 5,830 | 18,700[c] | 18,600[d] | 18,000[e] | 15,700[f] | 12,200[g] |

[a] The No Action waste volumes are from table 4.5.3.10–1. Waste volumes for tritium supply technologies and recycling were derived by adding the waste volumes of the various tritium supply technologies and recycling found in appendix section A.2 (tables A.2.1.1–4, A.2.1.2–4, A.2.1.3–4, A.2.1.3–5, A.2.1.4–4, and A.2.2.1–4) to the No Action volumes. Waste volumes have been rounded to three significant figures.

[b] The APT and recycling waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target waste volumes are approximately the same with the exception of solid LLW which is 447 $yd^3$.

[c] Includes 12,900 $yd^3$ of recyclable waste.

[d] Includes 12,800 $yd^3$ of recyclable waste.

[e] Includes 12,200 $yd^3$ of recyclable waste.

[f] Includes 9,900 $yd^3$ of recyclable waste.

[g] Includes 6,400 $yd^3$ of recyclable waste.

TABLE 4.5.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts at Pantex Plant from Tritium Supply Technologies and Recycling* [Page 1 of 2]

| | Tritium Supply and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Spent Nuclear Fuel** | New | New storage facility | New | New storage facility | New | New storage facility | New | New storage facility | None | None |
| **Low-Level** | | | | | | | | | | |
| Liquid | +525,000 | New treatment facility | +131,000 | New treatment facility | +1,250,000 | New treatment facility | +198,000 | New treatment facility | None | None |
| Solid | +22,200 | New staging facility, 92 LLW shipments | +6,600 | New staging facility, 27 LLW shipments | +4,240 | New staging facility, 32 LLW shipments | +4,040 | New staging facility, 18 LLW shipments | +3,580 | New staging facility, 16 LLW shipments |
| **Mixed Low-Level** | | | | | | | | | | |
| Liquid | +1 | None | +1 | None | +1 | None | +1 | None | +1 | None |
| Solid | +2,440 | Expand treatment and storage | +60 | None | +160 | None | +160 | None | +176 | None |
| **Hazardous** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +65 | None | +160 | None | +57 | None | +57 | None | +6 | None |
| **Nonhazardous (Sanitary)** | | | | | | | | | | |
| Liquid | +156 | Add or expand treatment facilities | +111 | Add or expand treatment facilities | +261 | Add or expand treatment facilities | +161 | Add or expand treatment facilities | +1,040 | Add or expand treatment facilities |
| Solid | +2,040 | Landfill life reduced or expansion required | +2,020 | Landfill life reduced or expansion required | +1,950 | Landfill life reduced or expansion required | +1,580 | Landfill life reduced or expansion required | +1,180 | Landfill life reduced or expansion required |

**TABLE 4.5.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts at Pantex Plant from Tritium Supply Technologies and Recycling* [Page 2 of 2]**

| | Tritium Supply and Recycling | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Nonhazardous (Other)** | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None |
| Solid | +222 | None-Project wastes are recyclable | +220 | None-Project wastes are recyclable | +210 | None-Project wastes are recyclable | +171 | None-Project wastes are recyclable | +110 | None-Project wastes are recyclable |

[a] This column reflects the percentage change in generation rate over No Action. Percentage change was calculated using waste volumes prior to rounding. Do not use rounded numbers in Table 4.5.3.10–2 to calculate percentage change.

Source: Tables 4.5.3.10–1; 4.5.3.10–2.

Siting an MHTGR without tritium recycling facilities at Pantex would not affect the generation of nor change the impacts from spent nuclear fuel and liquid LLW as described above and in table 4.5.3.10–3. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.5.3.10–3. The generation of solid LLW would increase by a factor of 53 over No Action and would still exceed the Pantex capability to stage while awaiting shipment to NTS. However, the total number of additional shipments would be reduced to 22. Approximately 3 acres per year of LLW disposal would be needed at NTS to accommodate this waste. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 21 to a factor of 11; thus, proportionately decreasing the impact to planned lifetime of the landfill.

*Advanced Light Water Reactor (Large).* Spent nuclear fuel would be generated at the rate of 30 $yd^3$ per year. The ALWR would be designed to provide the necessary treatment and storage of the spent nuclear fuel for the life of the facility. The liquid LLW generated from the ALWR would far exceed the limited existing treatment capability at Pantex. The Large ALWR would have to provide a liquid radioactive treatment capability. The facility would treat the liquid LLW into a solid form that would meet the waste acceptance criteria of the LLW disposal facility at NTS. The solid LLW generated from the ALWR would also exceed the Pantex capability to stage solid LLW prior to shipment to NTS. Expansion of existing facilities or the construction of a new facility would be examined in a site-specific NEPA analysis. Locating the Large ALWR at Pantex would require an additional 32 shipments of solid LLW to NTS per year. The additional LLW shipments would require approximately 4.5 acres per year of LLW disposal at NTS. The threefold increase in solid mixed LLW for the Large ALWR could be handled within the existing capability for staging since Pantex is currently handling about 50 $yd^3$ of mixed LLW. As seen in table 4.5.3.10–3, the increase in solid hazardous waste volumes could be handled within the existing and planned capability at Pantex. The capacity of the staging area is approximately 300 $yd^3$ with hazardous waste continually being shipped offsite. As in other technologies, the Large ALWR would generate larger quantities (factor of 3) of liquid sanitary wastes than currently projected for Pantex under No Action. Additional treatment facilities or expansion of existing or planned facilities would be necessary. The ALWR would increase by a factor of 21 the quantities of solid sanitary waste for the city of Amarillo landfill as compared to No Action. This would cause an increase in the need for landfill capacity at the city of Amarillo sanitary/industrial landfill.

Siting a Large ALWR without tritium recycling facilities at Pantex would not affect the generation of nor change the impacts from spent nuclear fuel and liquid LLW as described above and in table 4.5.3.10–3. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste streams generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.5.3.10–3. The generation of solid LLW would increase by a factor of 29 over No Action and would exceed the Pantex capability to stage while awaiting shipment to NTS. However, the total number of additional shipments would be reduced to 26. Approximately 3.8 acres per year of LLW disposal would be needed at NTS to accommodate this waste. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 21 to a factor of 9; thus, proportionately decreasing the impact to planned lifetime of the landfill.

*Advanced Light Water Reactor (Small).* Spent nuclear fuel would be generated at the rate of 15 $yd^3$ per year. The Small ALWR facility would be designed to provide the necessary treatment and storage of the spent nuclear fuel for the life of the facility. The liquid LLW generated from the Small ALWR facility would far exceed the limited existing treatment capability at Pantex. The Small ALWR facility would have to provide a liquid radioactive treatment capability to convert the liquid LLW into a solid form that would meet the waste acceptance criteria of the LLW disposal facility at NTS. The solid LLW generated from the ALWR facility would also exceed the Pantex capability to stage solid LLW prior to shipment to NTS. Expansion of existing facilities or the construction of a new facility would

be examined in site-specific, tiered NEPA documents. Locating the Small ALWR facility at Pantex would require an additional 18 shipments of solid LLW to NTS per year. This increase in LLW shipments would require approximately 2.5 acres of LLW disposal at NTS. The threefold increase in solid mixed LLW for the Small ALWR could be handled within the existing capability for staging since Pantex is currently handling about 50 $yd^3$ of mixed LLW. As seen in table 4.5.3.10–3, the slight increase in solid hazardous waste volumes could be handled within the existing and planned capability at Pantex since the staging capacity is almost 300 $yd^3$. As in the other technologies, the Small ALWR would generate larger quantities (factor of 2) of liquid sanitary wastes than currently projected for Pantex under No Action. Additional treatment facilities or expansion of existing or planned facilities would be necessary. The ALWR would increase the quantities of solid sanitary waste for the city of Amarillo landfill as compared to No Action by a factor of 17. This would cause an increase in the need for landfill capacity at the city of Amarillo sanitary/industrial landfill.

Siting a Small ALWR without tritium recycling facilities at Pantex would not affect the generation of nor change the impacts from spent fuel and liquid LLW as described above and in table 4.5.3.10–3. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.3.10–3. The generation of solid LLW would increase by a factor of 27 over No Action and would exceed the Pantex capability to stage while awaiting shipment to NTS. However, the total number of additional shipments would be reduced to 13. Approximately 2 acres per year of LLW disposal would be needed at NTS to accommodate this waste. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 17 to a factor of almost 7; thus proportionately decreasing the impact to the planned lifetime of the landfill.

*Accelerator Production of Tritium.* The APT does not generate spent nuclear fuel. Any liquid LLW can be solidified at the point of generation. The solid LLW generated from the APT would exceed the Pantex capability to stage solid LLW prior to shipment to NTS. Expansion of existing facilities or the construction of a new facility would be examined in a site-specific NEPA analysis. Locating the APT at Pantex would require an additional 16 shipments of solid LLW to NTS per year. The additional LLW shipments would require 2 acres per year of LLW disposal at NTS. The increase from 5 $yd^3$ to 14 $yd^3$ per year of solid mixed LLW would not require an expansion of the capability currently being studied pursuant to complying with the *Federal Facility Compliance Act* of 1992. The slight increase in solid hazardous waste volumes could be handled within the existing and planned capability at Pantex. The APT would increase by approximately a factor of 11 the amounts of liquid sanitary wastes than currently projected for Pantex under No Action. Additional treatment facilities or expansion of existing or planned facilities would be necessary. The APT would increase the quantities of solid sanitary waste for the city of Amarillo landfill as compared to No Action by a factor of 13. This would cause an increase in the need for landfill capacity at the city of Amarillo sanitary/industrial landfill.

Siting an APT without tritium recycling facilities at Pantex would not affect the generation of nor change the impacts from liquid LLW as described above and in table 4.5.3.10–3. Liquid mixed LLW and cooling tower blowdown would no longer be generated. All remaining waste stream generation rates would decrease; however, the impacts from solid mixed LLW, hazardous wastes, liquid sanitary wastes, and other solid nonhazardous wastes would not change from those described above and in table 4.5.3.10–3. The generation of solid LLW would increase by a factor of 23 over No Action and would still exceed the Pantex capability to stage while awaiting shipment to NTS. However, the total number of additional shipments would be reduced to 10. Approximately 1.5 acres per year of LLW disposal would be needed at NTS to accommodate this waste. The increase in generation rate over No Action for solid sanitary wastes would decrease from a factor of 13 to 3; thus proportionately decreasing the impact to the planned lifetime of the landfill.

*Less Than Baseline Operations.* In the event of a reduced baseline tritium requirement the waste volumes shown in table 4.5.3.10–2 would not appreciably change as a result of the HWR operating at less power and the MHTGR and ALWR irradiating fewer

target rods. In the case of a Phased APT using the helium-3 target, the waste volumes are approximately the same as the Full APT using the helium-3 target.

**Potential Mitigation Measures.** Each new tritium supply technology and recycling facility would be designed to process its own waste into a form suitable for storage or disposal and would use proven waste minimization and pollution prevention technologies to the extent possible. Some designs produce waste quantities or waste forms that could undergo additional reductions by utilizing the emerging technologies, thereby further reducing or mitigating impacts. Therefore, the impacts previously discussed could be substantially reduced. Pollution prevention and waste minimization would be considered in determining the final design of any facility constructed as part of the proposed action at Pantex. Pollution prevention and waste minimization would also be analyzed as part of site-specific tiered NEPA documents.

Some of the facilities such as Building 11-15A and Building 11-9 are planned to handle mixed wastes generated from past and current operations and from environmental restoration activities may be able to treat, store, or dispose of Complex wastes (DOE 1993a:5-12). Utilization of these existing facilities or the need for the construction of new facilities, as appropriate at the time, would be addressed in site-specific tiered NEPA documents.

The impact to the city of Amarillo sanitary landfill could be mitigated by considering possible onsite alternatives, financial assistance to the city or other possible offsite landfills. These alternatives would be addressed in a site-specific tiered NEPA document.

## 4.6 SAVANNAH RIVER SITE

SRS was established in 1950 as a nuclear materials production site and occupies approximately 192,000 acres south of Aiken, SC. The current defense program mission at SRS is to process tritium and conduct tritium recycling and filling in support of stockpile requirements. Section 3.3.6 provides a description of all the DOE missions and support facilities at SRS. The location of SRS within the South Carolina and Georgia region is illustrated in figure 4.6–1.

### 4.6.1 Description of Alternatives

Under the proposed action, any of the four tritium supply technologies (HWR, MHTGR, ALWR, and APT) could be located at SRS. Section 3.4.2 provides a description of these four technologies. In the event a tritium supply technology is sited at SRS, some of the tritium recycling support facilities would be upgraded to ensure compliance with ES&H requirements. The replacement tritium facility (Building 233-H) would not require upgrading since it meets current ES&H requirements. Figure 4.6.1–1 shows the locations of existing facilities within SRS and the TSS, and section 3.4.3.2 describes the tritium recycling facilities upgrade at SRS.

In the event tritium supply facilities are sited at any of the four other candidate sites (INEL, NTS, ORR, and Pantex), there are two recycling options. One option would be to upgrade existing recycling facilities located at SRS for continued use. The other option would be to collocate a new recycling facility with the supply facility. In this case, the existing tritium recycling facilities at SRS would be phased out and would eventually require D&D in accordance with DOE guidelines.

Under No Action, SRS would continue to perform the missions described in section 3.3.6 to include providing stockpile support by recycling tritium and conducting tritium filling. However, DOE would have no capability to produce new tritium. Future tritium requirements would be supported, for a limited time, by recycling tritium from weapons returned from the active stockpile.

### 4.6.2 Affected Environment

The following sections describe the affected environment at SRS for land resources, air quality and acoustics, water resources, geology and soils, biotic resources, cultural and paleontological resources, and socioeconomics. In addition, the infrastructure at SRS, the radiation and hazardous chemical environment, and the waste management conditions are described.

#### 4.6.2.1 *Land Resources*

The discussion of land resources at SRS includes land use and visual resources.

**Land Use.** SRS occupies approximately 192,000 acres in portions of Aiken, Allendale, and Barnwell counties in southwestern South Carolina, approximately 16 miles southeast of Augusta, GA. All of the land within SRS is owned by the Federal government and is administered, managed, and controlled by DOE. Generalized existing land uses at SRS and in the vicinity are shown in figure 4.6.2.1–1.

SRS land use can be grouped into three major categories: forest/undeveloped, water, and developed facility locations. Approximately 191,000 acres of SRS (approximately 96 percent) are undeveloped. Of this undeveloped acreage approximately 91 percent is forested. A forest management program has been in effect at SRS since 1952, when it was formed through an interagency agreement between DOE (then the Atomic Energy Commission) and the U.S. Forest Service (WSRC 1993a:317). The majority of the woodlands area (53 percent of the total site) is in revenue producing, managed timber production. There are no prime farmlands on SRS.

In 1972, DOE designated the entire SRS as a National Environmental Research Park. The National Environmental Research Park is used by the national scientific community to study the impact of human activities on the cypress swamp, and southeastern pine and hardwood forest ecosystems (DOE 1985a:1).

As shown in figure 4.6.2.1–1, the proposed TSS would be located northeast of N-Area within approximately 600 acres of forested lands typical of SRS.

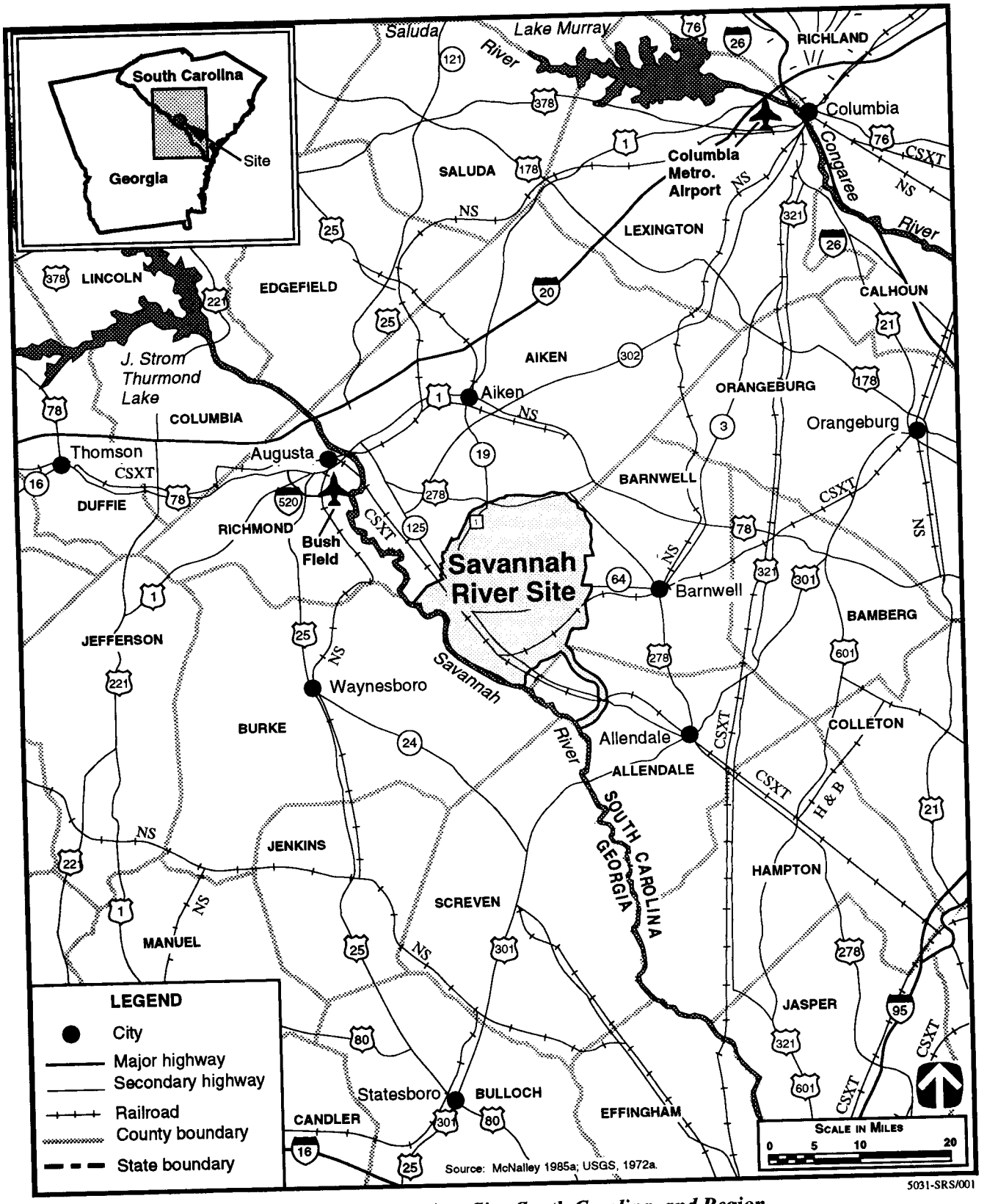



**FIGURE 4.6–1.—*Savannah River Site, South Carolina, and Region.***

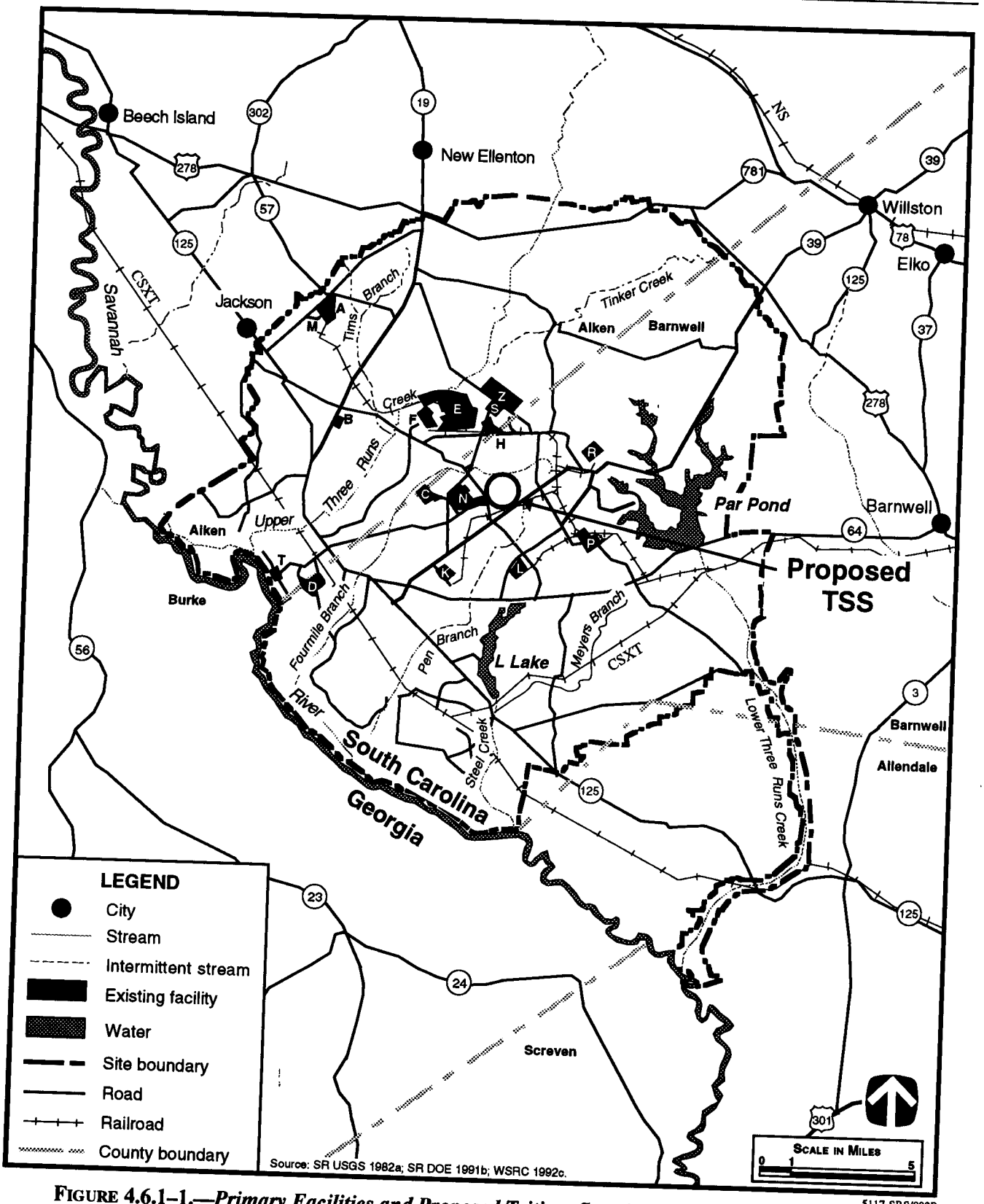



**FIGURE 4.6.1–1.**—*Primary Facilities and Proposed Tritium Supply Site at Savannah River Site.*

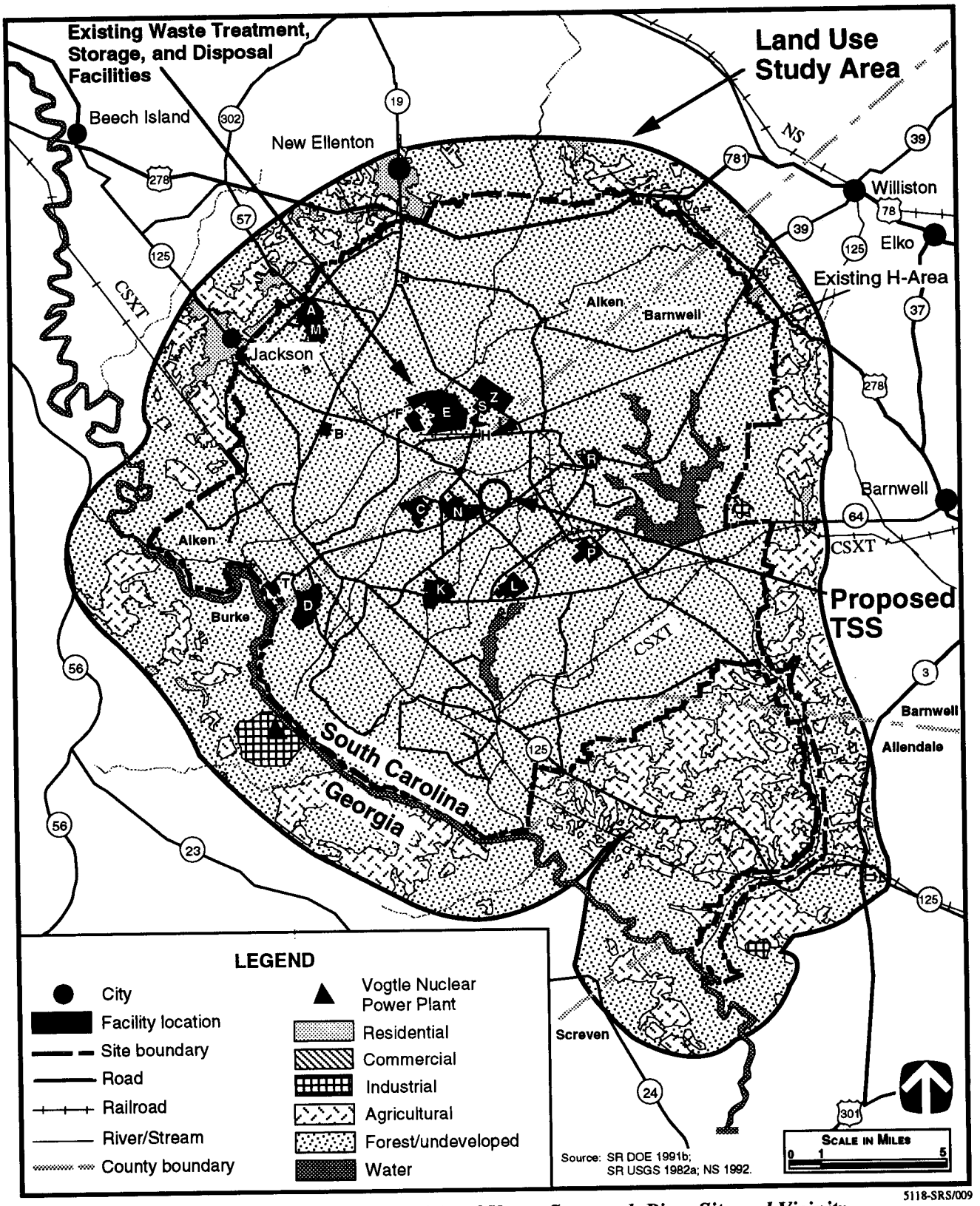



**FIGURE 4.6.2.1–1.**—*Generalized Land Use at Savannah River Site and Vicinity.*

The tritium recycling mission is currently located in H-Area.

Land use bordering SRS is primarily forest and agricultural, although there is a substantial amount of open water and nonforested wetland along the Savannah River Valley. Incorporated and industrial areas are the only other significant land uses in the vicinity. There is a small amount of urban and residential development bordering SRS. The closest residences include several located to the west, north, and northeast that are within 200 feet of the site boundary.

**Visual Resources.** The SRS landscape is characterized by swampland and upland hills. The vegetation is composed of bottomland hardwood forests, scrub oak and pine woodlands, and swamp forests. DOE facilities are scattered throughout SRS and are brightly lit at night. The developed areas and utility corridors (transmission lines and aboveground pipelines) of SRS are consistent with Class 5 VRM designation. The remainder of SRS generally ranges from a VRM classification of Class 3 to Class 4.

The viewshed consists mainly of agricultural and heavily forested land, with some limited residential and industrial areas. Views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. DOE facilities are generally not visible from offsite. The only areas with high visual sensitivity levels that are presently impacted by DOE facilities are the view corridors of State Highway 125, and SRS Road 1. The few other areas that have views of SRS facilities are quite distant (5 miles or more) and have low visual sensitivity levels.

### 4.6.2.2 *Site Infrastructure*

SRS contains extensive production, service, and research facilities. Not all of these facilities are in operation or needed today. Section 3.3.6 describes the current missions at SRS. To support these missions, an extensive infrastructure exists as shown in table 4.6.2.2–1. Of critical importance to the proposed action is the electrical power infrastructure at each potential site. The regional electrical power pool area in which SRS is located and from which it draws its power is the Virginia-Carolina Subregion. Characteristics of this power pool are given in table 4.6.2.2–2.

**TABLE 4.6.2.2–1.—*Baseline Characteristics for Savannah River Site***

| Current Characteristics | Value |
|---|---|
| **Land** | |
| Area (acres) | 192,000 |
| Roads (miles) | 150 |
| Railroads (miles) | 57 |
| **Electrical** | |
| Energy consumption (MWh/yr) | 659,000 |
| Peak load (MWe) | 130 |
| **Fuel** | |
| Natural gas ($ft^3$/yr) | 0 |
| Oil (GPY) | 2,412,000 |
| Coal (ton/yr) | 230,000 |
| **Steam** (lb/hr) | 2,584,000 |

Source: SRS 1993a:3.

**TABLE 4.6.2.2–2.—*Regional Power Pool Electrical Summary for Savannah River Site***

| Type Fuel | Production (percent) |
|---|---|
| Coal | 50 |
| Nuclear | 36 |
| Hydro/geothermal | 2 |
| Oil/gas | 4 |
| Other[a] | 8 |
| **Total Annual Production:** 272,155,000 MWh | |
| **Total Annual Load:** 284,556,000 MWh | |
| **Energy Imported Annually[b]:** 13,846,000 MWh | |
| **Generating Capacity:** 61,931 MWe | |
| **Peak Demand:** 55,477 MWe | |
| **Capacity Margin[c]:** 10,443 MWe | |

[a] Includes power from nonutility sources only.
[b] Energy imported is not the difference of production and load due to system losses and pumped storage.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

### 4.6.2.3 *Air Quality and Acoustics*

The following describes existing air quality and acoustics including a review of the meteorology and climatology in the vicinity of SRS. More detailed discussions of the air quality and acoustics methodologies, input data, and atmospheric dispersion characteristics are presented in appendix section B.1.3.6.

**Meteorology and Climatology.** The SRS region has a temperate climate with short, mild winters and long, humid summers. Throughout the year, it is frequently affected by warm and moist maritime air masses (Trewartha 1954a). The annual average temperature at SRS is 66 °F; average daily temperatures vary from 37.9 °F in January to 90.8 °F in July. The average annual precipitation at SRS is 49.7 inches (NOAA 1991b). Prevailing winds at SRS are from the southwest through west-northwest and from the northeast and east-northeast. The annual average wind speed is 12.8 mph. Additional information related to meteorology and climatology at SRS is presented in appendix section B.1.3.6.

**Ambient Air Quality.** SRS is located near the center of the Augusta-Aiken Interstate AQCR. As of 1991, the areas within SRS and its surrounding counties were in attainment with respect to the NAAQS for criteria pollutants (40 CFR 50; 40 CFR 81.311; 40 CFR 81.341). Applicable NAAQS and the ambient air quality standards for South Carolina and Georgia are presented in appendix table B.1.3.1–1.

Since the promulgation of Prevention of Significant Deterioration regulations (40 CFR 52.21) in 1977, Prevention of Significant Deterioration permits have not been required for any new SRS emission sources nor modifications required to existing permits. There are no known Prevention of Significant Deterioration Class I areas in the vicinity of SRS.

Maximum pollutant concentrations measured during 1985 at onsite air quality monitoring stations and at nearby monitoring stations outside SRS are listed in appendix table B.1.3.6–1. All concentrations measured at these stations indicate that ambient concentrations in and near SRS are within the NAAQS and applicable state ambient air quality standards with the exception of ozone ($O_3$). The $O_3$ standard was equaled at one monitoring station on one day in 1985 (WSRC 1989a).

The emissions inventory from sources at SRS for criteria pollutants are presented in appendix table B.1.3.6–2. Historically, the primary emission sources of criteria air pollutants at SRS are the 9 coal-burning and 4 fuel oil-burning boilers that produce steam and electricity (A-, D-, H-, K-, and P-Areas), the fuel and target fabrication facilities (M-Area), and processing facilities (F- and H-Areas). Other emissions and sources include fugitive particulates from coal piles and coal-processing facilities, vehicles, and temporary emissions from various construction-related activities.

Hazardous/toxic air pollutant emissions from SRS operations for which an ambient standard has been adopted by the State of South Carolina Department of Health and Environmental Control include aldehydes (assumed to be formaldehyde), carbon tetrachloride, nitric acid, and 1,1,1-trichloroethane. (No ambient standards for hazardous/toxic air pollutants have been proposed or established by the State of Georgia.) The annual emission rates of hazardous/toxic air pollutants from existing SRS facilities during 1990 and estimates of maximum 24-hour average ground-level concentrations at the SRS boundary are listed in appendix table B.1.3.6–3. These estimates are in compliance with applicable standards.

Table 4.6.2.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at SRS. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

**Acoustic Conditions.** Major noise emission sources at SRS are primarily located in developed or active areas and include various industrial facilities, equipment, and machines. Noise emitted from the site is barely distinguishable from background noise levels at the SRS boundary. Major noise emission sources outside of active areas consist primarily of vehicles and rail operations. Some of these offsite noise emissions can be attributed to SRS activities and have an effect on noise levels along site access highways through the nearby towns of New Ellenton, Jackson, and Aiken.

**TABLE 4.6.2.3–1.—*Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations and Guidelines at Savannah River Site, 1985-1987***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Baseline Concentration ($\mu g/m^3$)[a] |
|---|---|---|---|
| **Criteria Pollutant** | | | |
| Carbon monoxide (CO) | 8-hour | 10,000[b] | 38 |
| | 1-hour | 40,000[b] | 154 |
| Lead (Pb) | Calendar quarter | 1.5[b] | c |
| Nitrogen dioxide ($NO_2$) | Annual | 100[b] | 22 |
| Ozone ($O_3$) | 1-hour | 235[b] | 235 |
| Particulate matter ($PM_{10}$) | Annual | 50[b] | 28 |
| | 24-hour | 150[b] | 64 |
| Sulfur dioxide ($SO_2$) | Annual | 80[b] | 16 |
| | 24-hour | 365[b] | 266 |
| | 3-hour | 1,300[b] | 1,122 |
| **Mandated by South Carolina** | | | |
| Total suspended particulates (TSP) | Annual | 75[d] | 29 |
| **Hazardous and Other Toxic Compounds** | | | |
| Nitric acid | 24-hour | 125[d] | 3.2 |
| 1,1,1–Trichloroethane | 24-hour | 9,550[d] | 3.6 |
| Trichlorotrifluoroethane | 24-hour | No standard | 1.8 |

[a] The total concentration represents a conservative assessment of air quality since the concentration contributions from individual sources do not necessarily occur at the same location.
[b] Federal standard (40 CFR 50).
[c] Not estimated because the potential release is negligible.
[d] State standard (SR DHEC 1991a).
Source: DOE 1992k.

The States of Georgia and South Carolina, and the counties in which SRS is located, have not established any noise regulations that specify acceptable community noise levels, with the exception of a provision in the Aiken County Nuisance Ordinance which limits daytime and nighttime noise by frequency band (appendix table B.2.2.2–1).

### 4.6.2.4 *Water Resources*

This section describes the surface water and groundwater resources at SRS.

**Surface Water.** The most prominent hydrologic feature at SRS is the Savannah River, bordering the site for 20 miles to the southwest (figure 4.6.2.4–1). Six major streams flow through SRS to the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Upper Three Runs has two tributaries, Tims Branch and Tinker Creek; Pen Branch has one tributary, Indian Grave Branch; and Steel Creek has one tributary, Meyers Branch (WSRC 1992a).

SRS withdraws surface water from Savannah River mainly for industrial water cooling purposes. A small quantity is also removed for drinking water supplies. Total water supplied from the Savannah River is currently 19,840 MGY. Most of the water withdrawn is returned to the Savannah River through its onsite tributaries. Streams, especially Fourmile Branch, that received discharges from reactors in the past, are still recovering from scouring or erosion impacts. The average flow of the Savannah River is 10,000 $ft^3/s$. The lowest recorded flow, 6,500 $ft^3/s$, occurred during a drought period from 1985 to 1988 (SR DOE 1990b). The proposed TSS could affect the Fourmile Branch drainage basin, which also receives

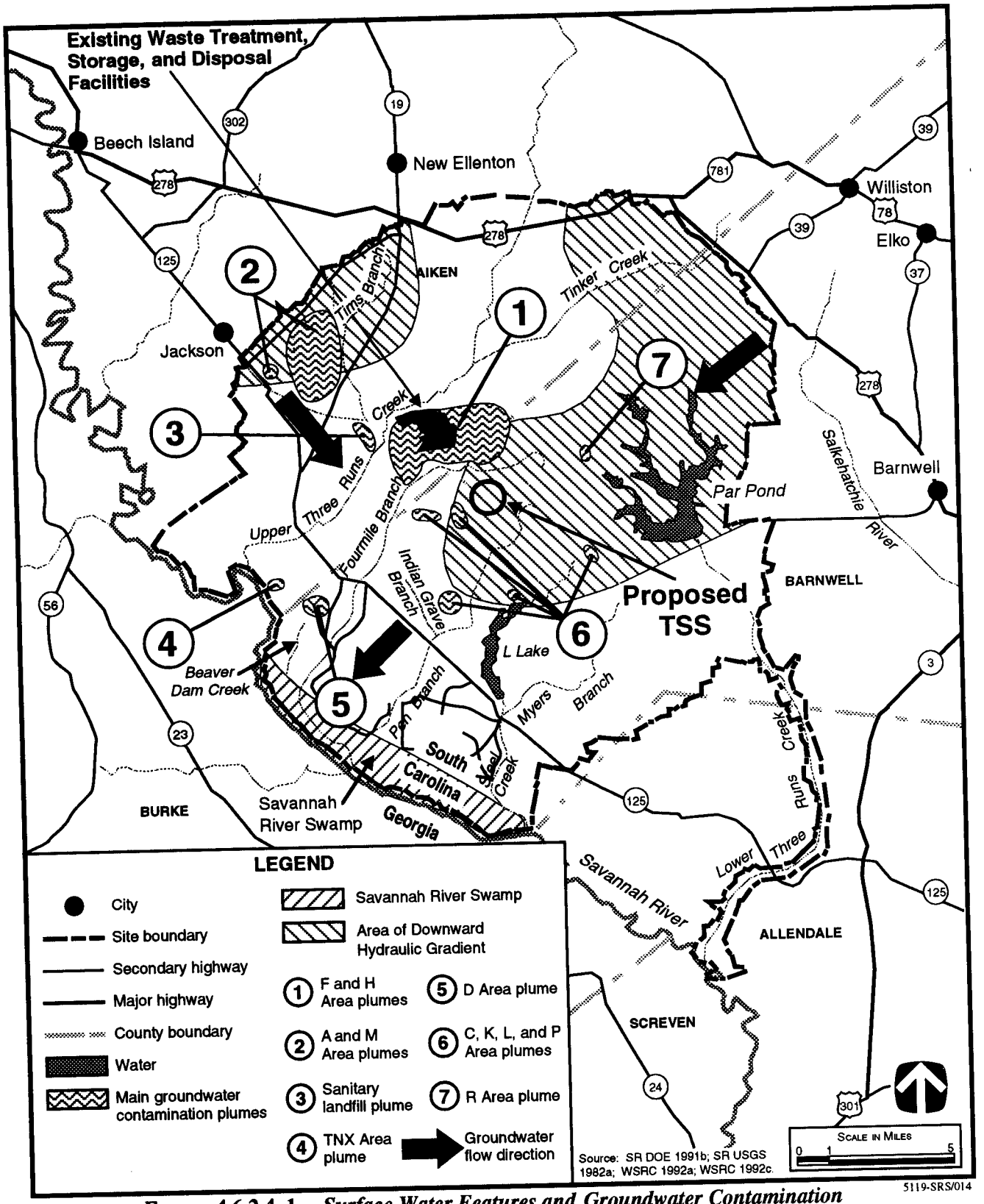



**FIGURE 4.6.2.4–1.**—***Surface Water Features and Groundwater Contamination Areas at Savannah River Site.***

effluents from C-, F-, and H-Areas; however, Pen Branch could also receive discharges.

There are two man-made water bodies on SRS: L-Lake, which discharges to Steel Creek; and Par Pond, which empties into Lower Three Runs Creek (WSRC 1992a).

There are approximately 190 Carolina bays scattered throughout the site. Carolina bays are naturally-occurring closed depressions that may hold water (SR NERP 1989a). There are no direct discharges to the bays; however, some do receive stormwater runoff.

The proposed TSS is outside any 100-year floodplains (SR DOE 1990b). Information on the location of 500-year floodplains at SRS is currently not available; however, a site-specific assessment would be required before constructing any tritium supply and recycling facilities at SRS.

**Surface Water Quality.** In the vicinity of SRS, the Savannah River and onsite streams are classified as fresh water suitable for: primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control; fishing and the survival and propagation of a balanced indigenous and aquatic community of fauna and flora; and industrial and agricultural uses (SR DHEC 1992a). Table 4.6.2.4–1 lists the surface water monitoring results for the Savannah River. No parameters exceed South Carolina water quality criteria for the Savannah River (WSRC 1992a).

In addition to water quality monitoring, SRS conducts monitoring to ensure compliance with NPDES permit limits. SRS has three NPDES permits that cover 78 outfalls. Of the 8,329 analyses performed at these outfalls in 1991, seven exceeded permit limits. Noncompliances were noted for pH, fecal coliforms, oil and grease, biological oxygen demand, flow, and total suspended solids. Except in the case of pH noncompliance, corrective actions were taken to prevent future noncompliances (WSRC 1992a).

**Surface Water Rights and Permits.** Surface water rights for the Savannah River are determined by the Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely impact quantity or quality of water availability for downstream users.

**Groundwater.** Several aquifer system naming schemes have been used at SRS. For this document, the most shallow aquifer will be called the water table. The water table is supported by the leaky "Green Clay" aquitard, which confines the Congaree aquifer. Below the Congaree aquifer is the leaky Ellenton aquitard, which contains the Cretaceous (or also in the past the Tuscaloosa) aquifer. In general at SRS, groundwater in the water table flows downward to the Congaree aquifer or to nearby streams that intersect the water table. Flow in the Congaree aquifer is downward to the Cretaceous aquifer or horizontally to Upper Three Runs Creek or the Savannah River, depending on the position at SRS. Groundwater in the Cretaceous aquifer discharges predominantly along the Savannah River. However, Upper Three Runs Creek also receives groundwater from the Cretaceous aquifer and this flow creates an upward gradient between the Cretaceous and Congaree aquifer over a significant portion of SRS (figure 4.6.2.4–1).

The Cretaceous aquifer is an abundant and important water resource for the SRS region. Some of the local cities (Aiken for example) also obtain groundwater from the Cretaceous, but most of the rural population in the SRS region gets its water from the Congaree or water table. All groundwater at SRS is classified by the EPA as a Class II water source (current potential source of drinking water).

Characterization wells installed for preliminary hydrogeologic evaluation of the TSS indicate that the site is located near a water table divide between Fourmile Branch and Pen Branch. That is, groundwater in the water table on the northern side of the divide flows horizontally to Fourmile Branch and on the southern side to Pen Branch. Groundwater in the water table also flows vertically to the Congaree aquifer which discharges at Upper Three Runs Creek. The Cretaceous aquifer is protected from any potential contamination at the TSS by the Ellenton aquitard and the upward hydraulic gradient between the Cretaceous and Congaree aquifers. Groundwater at the TSS is approximately 20 to 60 feet below the ground surface.

**TABLE 4.6.2.4–1.—*Summary of Surface Water Quality Monitoring at Savannah River Site***

| | Receiving Water: Savannah River, 1991 | | |
|---|---|---|---|
| **Parameter** | **Unit of Measure** | **Water Quality Criteria[a]** | **Average Water Body Concentration** |
| Alkalinity | mg/l | NA | 18 |
| Alpha (gross) | pCi/l | 15[b] | 0.004 |
| Aluminum | mg/l | 0.05-0.2[c] | 0.79[g] |
| Ammonia | mg/l | NA | 0.12 |
| Beta (nonvolatile) | pCi/l | 50[d] | 2.05 |
| Calcium | mg/l | NA | 4.4[g] |
| Cesium-137 | pCi/l | 120[e] | 0.0493 |
| Chemical oxygen demand | mg/l | NA | 14 |
| Chloride | mg/l | 250[c] | 7.2 |
| Chromium | mg/l | 0.1[b] | <0.02[g] |
| Conductivity | µmhos/cm | NA | 81 |
| Dissolved oxygen | mg/l | >5[f] | 7.8 |
| Iron | mg/l | 0.3[c] | 1.8[g] |
| Lead | mg/l | 0.015[b] | 0.01[g] |
| Magnesium | mg/l | NA | 1.4[g] |
| Manganese | mg/l | 0.05[c] | 0.13[g] |
| Nitrogen (as $NO_2/NO_3$) | mg/l | NA | 0.25 |
| pH | pH units | 6.5-8.5[f] | 7.5[g] |
| Phosphorus | mg/l | NA | 0.09 |
| Plutonium-238 | pCi/l | 1.6[e] | 0.00028 |
| Plutonium-239 | pCi/l | 1.2[e] | 0.0007 |
| Sodium | mg/l | NA | 10[g] |
| Strontium-90 | pCi/l | 8[b] | 0.137 |
| Sulfate | mg/l | 250[c] | 7.8 |
| Suspended solids | mg/l | NA | 16 |
| Temperature | °C | 32.2[f] | 18 |
| Total dissolved solids | mg/l | 500[c] | 64 |
| Tritium | pCi/l | 20,000[b] | 3,250 |
| Turbidity | turbidity unit | 1-5[b] | 10 |
| Zinc | mg/l | 5[c] | <0.01[g] |

[a] For comparison only, except for parameters which have South Carolina water quality criteria.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] National Secondary Drinking Water Regulations (40 CFR 143).
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.
[f] South Carolina state water quality criteria.
[g] Average concentrations were not calculated because of an insufficient amount of sampling. The maximum concentration is listed.
Note: NA - not applicable.
Source: WSRC 1992a.

**Groundwater Quality.** Groundwater data have been obtained from SRS monitoring wells for the past several years. Groundwater quality at SRS ranges from excellent (soft and slightly acidic) to below EPA drinking water standards on several constituents in the vicinity of some waste sites. The Cretaceous aquifer is generally unaffected except for a small portion of the A-Area which has trichloroethylene. The Congaree aquifer is contaminated with trichloroethylene in much of the A- and M-Areas with trichloroethylene and also some low levels of tritium in the General Separations Area. The water table is contaminated with solvents and/or metals and/or low levels of radionuclides at several waste sites and facilities at the F- and H-Areas. All contaminated groundwater at SRS discharges at streams on the SRS or the Savannah River.

Based on the operating history of SRS, groundwater at the TSS should meet drinking water standards. Also, results of groundwater quality measurements from 2 of the 16 TSS characterization wells and comparison with standards or criteria for selected quality parameters are presented in table 4.6.2.4–2. As can be seen from that table, when compared to national primary and secondary maximum contaminant levels, parameter concentrations are within acceptable limits except for pH in one of the wells. The elevated pH is most likely due to the well completion with grout and not actual groundwater impacts.

**Groundwater Availability, Use, and Rights.** SRS is one of 56 major municipal, industrial, and agricultural groundwater users in the region. Within a 20-mile radius of the site the total pumpage for these 56 users averages about 12,900 MGY (WSRC 1991c).

TABLE 4.6.2.4–2.—*Groundwater Quality Monitoring at Savannah River Site*[a]

| Parameter | Unit of Measure | Water Quality Criteria and Standards[b] | Existing Conditions, 1991 | |
|---|---|---|---|---|
| | | | Well No. NPM 2 | Well No. NPM 19E |
| Alpha (gross) | pCi/l | 15[d] | <2 | <2 |
| Barium | mg/l | 2[c] | 0.008 | 0.013 |
| Beta (nonvolatile) | pCi/l | 50[d] | <2 | 33 |
| Chloride | mg/l | 250[e] | 0.002 | 0.003 |
| Iron | mg/l | 0.3[e] | <0.004 | 0.036 |
| Lead | mg/l | 0.015[c] | <0.003 | 0.003 |
| Manganese | mg/l | 0.05[e] | 0.015 | <0.002 |
| Nitrate | mg/l | 10[c] | 0.15 | 0.06 |
| pH | pH units | 6.5-8.5[e] | 6.6 | 12 |
| Phenols | mg/l | NA | <0.005 | <0.005 |
| Sulfate | mg/l | 250[e] | <0.001 | 0.037 |
| Total dissolved solids | mg/l | 500[e] | 0.029 | 0.023 |
| Total organic halogens | mg/l | NA | <0.005 | 0.02 |
| Total phosphates | mg/l | NA | 0.09 | <0.05 |
| Total radium | pCi/l | 5[f] | 2 | 1 |
| Tritium | pCi/l | 20,000[c] | 7,000 | 700 |

[a] All data are from wells located at the proposed TSS.
[b] For comparison only.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE's Derived Concentration Guides for water (DOE Order 5400.5). Derived Concentration Guides values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the Derived Concentration Guides.
Note: NA - not applicable.

Groundwater use at SRS totals approximately 3,146 MGY, which represents approximately 24 percent of the total groundwater used in the area (SR DOE 1993).

The majority of the water supply systems within the region use groundwater, but the systems serving Aiken, North Augusta, Columbia County, and Richmond County also draw a portion of their water supplies from surface water. Currently, most county systems within the region have average daily demands of 40 to 57 percent of their design capacities (DOE 1993f).

Groundwater rights in South Carolina are traditionally associated with property ownership. The *Water Use Reporting and Coordination Act* requires all users of 100,000 gallons or more per day (36 MGY) of water to report their withdrawal rates to the South Carolina Water Resources Commission. SRS groundwater use exceeds this amount, and consequently, reports its withdrawal rates to the commission (DOE 1992e).

#### 4.6.2.5 *Geology and Soils*

**Geology.** SRS is located in the Aiken Plateau portion of the Upper Atlantic Coastal Plain east of the Fall Line, a major physiographic and structural feature that separates the Piedmont and the Coastal Plain, in southeastern South Carolina.

The plateau is highly dissected, with narrow, steep-sided valleys separated by broad flat areas. In the immediate region of SRS there are no known capable faults within the definition of 10 CFR 100, Appendix A. There is evidence from subsurface mapping and seismic surveys that suggests the presence of faults beneath SRS. The largest of these is the Pen Branch fault. However, there is no evidence of movement within the last 38 million years along this fault (WSRC 1991a).

SRS lies within Seismic Zone 2A, indicating moderate damage could occur as a result of earthquakes (figure 4.2.2.5–2). Since 1985 only three earthquakes, all of Richter magnitude 3.0 or less, have occurred in the immediate area of SRS. None of these earthquakes produced any damage at SRS. Historically, two large earthquakes have occurred within 180 miles of SRS. The largest of these two, the Charleston earthquake of 1886, had an estimated magnitude of 7.5. Earthquakes capable of producing structural damage to any buildings are not likely to occur in the vicinity of SRS (Stephenson 1988a). There is no volcanic hazard at SRS. The area has not experienced volcanism within the last 230 million years.

**Soils.** The soils of the proposed TSS are mainly sands and sandy loams. The somewhat excessively drained soils have a thick, sandy surface layer that extends to a depth of 80 inches or more in some areas (SR USDA 1990a). Many of the soils are subject to erosion, flooding, ponding, and cutbank caving. The soils at SRS are considered acceptable for standard construction techniques.

#### 4.6.2.6 *Biotic Resources*

The following describes biotic resources at SRS including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Within each biotic resource area the discussion focuses first on SRS as a whole and then the proposed TSS. Scientific names of species identified in the text are presented in appendix C. Also presented in the appendix is a list of threatened and endangered species that may be found on the site or in the vicinity of SRS.

**Terrestrial Resources.** Most of SRS has remained undeveloped since it was established in 1951. Only about 5 percent of the site is occupied by DOE facilities. Five major plant communities have been identified at SRS (figure 4.6.2.6–1). Of these, the largest is the loblolly-longleaf-slash pine community, which covers approximately 65 percent of SRS. This community type, as well as upland hardwood-scrub oak, occurs primarily in upland areas. Swamp forests and bottomland hardwood forests are found along the Savannah River and the numerous streams that traverse SRS. More than 1,300 species and variations of vascular plants have been identified on the site (DOE 1992e).

Because of the variety of plant communities on the site, as well as the region's mild climate, SRS supports a diversity and abundance of wildlife including: 43 amphibian, 58 reptile, 213 bird, and 54 mammal species. Common species at SRS include the slimy salamander, box turtle, Carolina chickadee,

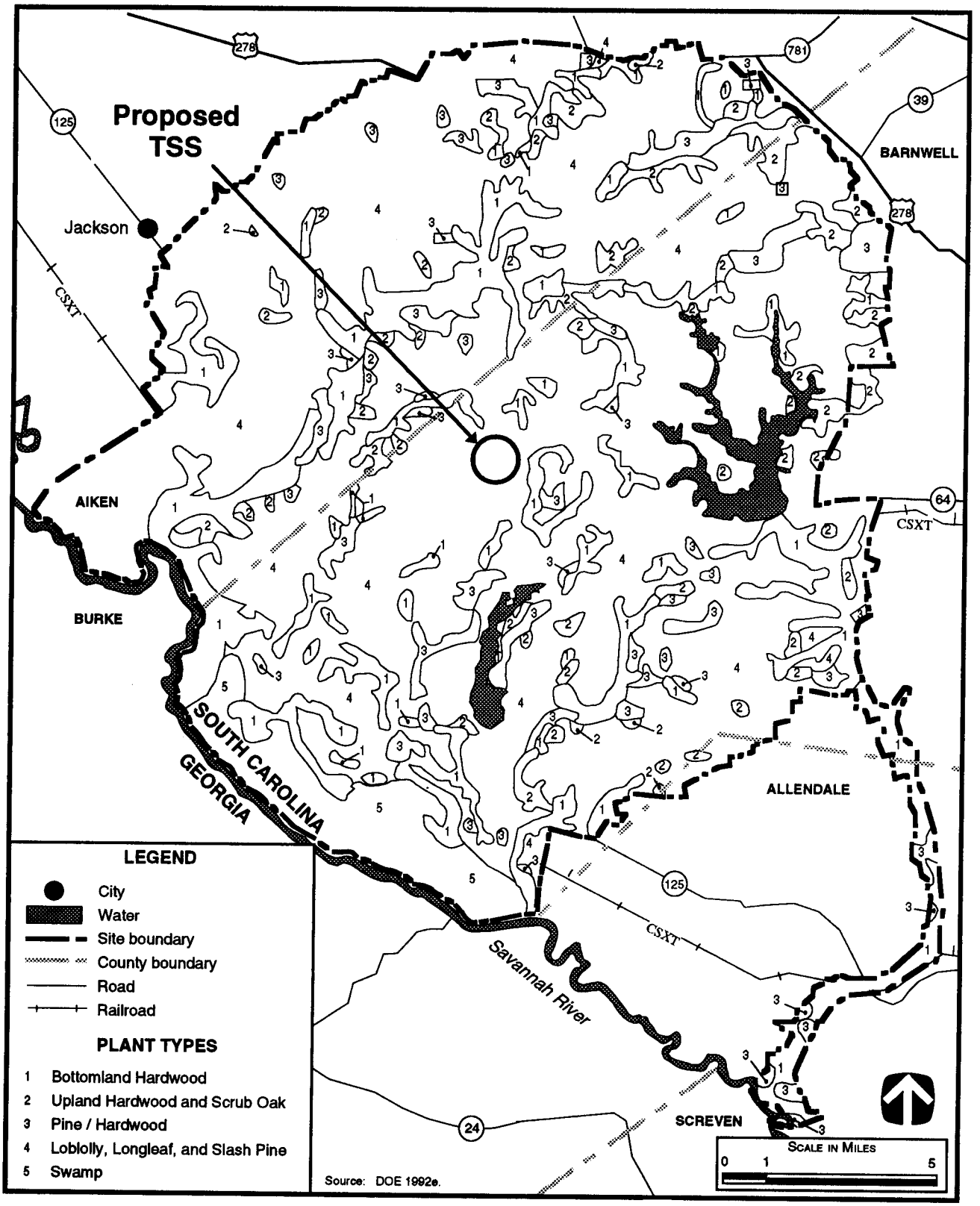



**FIGURE 4.6.2.6–1.**—*Distribution of Plant Communities at Savannah River Site.*

common crow, eastern cottontail, and gray fox (DOE 1992e; WSRC 1993b). A number of game animals are found on SRS; however, only the whitetail deer and feral hog are hunted onsite (DOE 1992e). Raptors, such as the Cooper's hawk and black vulture, and carnivores, such as the gray fox and raccoon, are ecologically important groups on SRS. A variety of migratory birds has been found at SRS. Migratory birds, their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

The proposed TSS is located within an area dominated by the loblolly-longleaf-slash pine community (figure 4.6.2.6–1). Reconnaissance surveys and analysis of aerial photographs indicate that pine plantations occupy most of the plant cover in the proposed TSS. These pine plantations contain slash pine and loblolly pine ranging in age from new plantings to immature trees. Other vegetation types found on the proposed TSS include old-field, bottomland hardwood forest, mixed forest, upland deciduous forest, grassland, and emergent wetland (DOE 1992e). Animals found on the proposed TSS are expected to be similar to those found in similar habitats elsewhere on SRS.

**Wetlands.** SRS contains approximately 49,000 acres of wetlands, most of which are associated with flood plains, streams, and impoundments. Wetlands on the site may be divided into the following categories: bottomland hardwoods, cypress-tupelo, scrub-shrub, emergent, and open water (WSRC 1993b). The most extensive wetland type on SRS is swamp forest associated with the Savannah River floodplain. Approximately 9,400 acres of these wetlands are found on SRS. Past releases of cooling water effluent into site streams and the Savannah River Swamp have resulted in shifts in plant community composition. Changes have included the replacement of bald cypress by scrub-shrub and emergent vegetation in the swamp and reduction in bottomland forests along streams (DOE 1992e; WSRC 1989e).

Carolina bays, a type of wetland unique to the southeastern United States, are also found on SRS. Approximately 190 Carolina bays have been identified on the site. These natural shallow depressions occur on interstream areas of SRS and range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or swamp forests (SR NERP 1989a).

A previous tritium reactor study identified approximately 46 acres of jurisdictional wetlands in the vicinity of the proposed TSS. Several of these identified wetlands occur along intermittent tributaries to Pen Branch and Fourmile Branch and are periodically flooded bottomland hardwood forest (DOE 1992e).

Rainbow Bay, a 4-acre Carolina bay situated near the proposed TSS, has been the subject of a number of ecological studies. Due to its significance as a natural resource, a 600-foot-plus buffer around Rainbow Bay has been established (SRS 1992a:8).

**Aquatic Resources.** Aquatic habitat on SRS includes man-made ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 man-made impoundments located throughout the site that mainly support populations of bass and sunfish (SR DOE 1982a; SRS 1992a:8). Fewer than 20 Carolina bays have permanent fish populations. Species present in these bays include redfin pickerel, mud sunfish, lake chubsucker, and mosquitofish (SR NERP 1983a; SR NERP 1989a).

Par Pond and L-Lake support similar fish populations including largemouth bass, black crappie, and various species of pan fish (SRS 1992a:8). Recreational fishing is not allowed on the SRS site (DOE 1992e; WSRC 1989e).

The Savannah River is used for both commercial and sport fishing. Important commercial species are American shad, hickory shad, and striped bass, all of which are anadromous. The most important warm water game fish species of the Savannah River are bass, pickerel, crappie, bream, and catfish (SR DOE 1982a). In the past, water intake structures for C- and K-Reactors and the D-Area powerhouse caused annual estimated entrainment of approximately 10 percent of the fish eggs and larvae passing the intake canals during the spawning season. In addition, estimated impingement losses were approximately 7,600 fish per year (SR DOE 1987b).

Aquatic habitat in the vicinity of the proposed TSS consists of Fourmile Branch, Pen Branch, and Rainbow Bay (DOE 1992e; SR NERP 1983a). In the

past, Fourmile Branch and Pen Branch have received thermal effluents from C- and K-Reactors, respectively. During reactor operation, fish populations in warmed portions of the streams were greatly reduced, with the mosquitofish the most commonly occurring species. During the shutdown of the reactors, fish, including largemouth bass, lake chubsucker, chain pickerel, and redbreast sunfish, have recolonized portions of Pen Branch (WSRC 1989e). DOE entered into two settlement agreements under the CWA in 1990 agreeing to address high temperature discharges and related fish kills on SRS (discussed in Appendix section A.1.5). The K-Reactor cooling tower was completed in 1992 but the reactor is in cold standby with no provision for restart. Above the reactor outfalls, both Fourmile Branch and Pen Branch are small streams that have been relatively unaffected by past SRS operations. The dominant fish in the non-heated upper reaches of Pen Branch include sunfish, bullheads, and chubsuckers (SR DOE 1987b); species composition of the upper portion of Fourmile Branch would be expected to be similar.

**Threatened and Endangered Species.** Sixty-one Federal- and state-listed threatened, endangered, and other special status species have been identified on and in the vicinity of SRS (appendix table C–6). Table 4.6.2.6–1 lists the species that may occur in areas on or near the proposed TSS. Field surveillance would be required to determine their presence. No critical habitat for threatened or endangered species, as defined in the *Endangered Species Act* (50 CFR 17.11; 50 CFR 17.12), exists on SRS. Suitable habitats do exist in the area of the proposed TSS for a number of Federal candidate and state special status species as noted in table 4.6.2.6–1.

There are no Federal-listed threatened and endangered species known to occur on the proposed TSS, however, several may exist in the general vicinity. Bald eagles have been observed at several locations on SRS, particularly in the vicinity of Par Pond and L-Lake. Active bald eagle nests are located 7.5 miles southwest of the proposed TSS in an area of Pen Branch and 7.5 miles southeast of the TSS just south of Par Pond (WSRC 1993b). Wood storks foraging in the Savannah River swamp have been observed near the Fourmile Branch delta 11 miles from the proposed TSS. Although suitable forage habitat for the red-cockaded woodpecker exists in the proposed TSS, the closest colony is located 8 miles away. The American alligator is a common inhabitant of Par Pond, Beaver Dam Creek, and the Savannah River swamp, all located 5 miles or more from the proposed TSS. No self-sustaining, reproducing populations of the alligator have been observed in Fourmile Branch or its delta. The shortnose sturgeon spawns in the Savannah River upstream of SRS, and larvae of this species have been collected in or near the water intake canals on the river. However, entrainment or impingement of this species at SRS water intake structures has not been documented (DOE 1992e). Another Federal-listed species, the smooth purple coneflower, has not been recorded in affected areas but could be found in the proposed TSS. Awned meadow-beauty have been found near Rainbow Bay located adjacent to the proposed TSS.

Several state special status species have also been found near Rainbow Bay, including the Cooper's hawk, two species of beak-rush, Florida false loosestrife, and green-fringed orchid.

#### 4.6.2.7 *Cultural and Paleontological Resources*

**Prehistoric Resources.** Prehistoric site types on the SRS consist of villages, base camps, limited activity sites, quarries, and workshops. An extensive archaeological survey program began at SRS in 1974 encompassing numerous field studies such as reconnaissance survey, shovel test transects and intensive site testing and excavation. More than 60 percent of SRS has received some level of cultural resources evaluation. More than 800 prehistoric sites have been identified, however, fewer than 8 percent have been evaluated for eligibility to the NRHP. Of these, 10 prehistoric sites have been determined NRHP-eligible.

Several cultural resource studies including a reconnaissance survey, an intensive inventory, and site testing have been conducted for the proposed TSS. Nine prehistoric sites were recorded but none of these sites were considered NRHP-eligible.

**Historic Resources.** Types of historic sites include cattle ranches, farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, commercial building locations, trash scatters, roads, and logging railroads.

**TABLE 4.6.2.6–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of the Proposed Tritium Supply Site at Savannah River Site***

| Species | Status[a] Federal | State | Known or Potential Habitat/Location |
|---|---|---|---|
| **Mammals** | | | |
| Star-nosed mole | NL | UN | Low wet ground |
| **Birds** | | | |
| Bald eagle[b] | E | SE | Active nest on Pen Branch and south of Par Pond |
| Cooper's hawk[c] | NL | UN | Broken woodland |
| Red-cockaded woodpecker[b] | E | SE | Pine forest |
| Wood stork[b,d] | E | SE | Savannah River swamp |
| **Reptiles** | | | |
| American alligator | T | NL | Savannah River swamp |
| **Amphibians** | | | |
| Carolina crawfish frog | C2 | SC | Gopher tortoise and crawfish burrows |
| Eastern tiger salamander[d] | NL | SC | Savannah River swamp and Carolina bays |
| Pickerel frog[d] | NL | UN | Savannah River swamp |
| **Fishes** | | | |
| Shortnose sturgeon[b,d] | E | SE | Savannah River |
| **Plants** | | | |
| Awned meadow-beauty[c] | C2 | NL | Carolina bays |
| Beak-rush[b] *(Rhychospora inundata)* | NL | UN | Carolina bays |
| Beak-rush[b] *(Rhychospora tracyi)* | NL | UN | Carolina bays |
| Cypress stump sedge[d] | NL | UN | Savannah River swamp |
| Elliott's croton | NL | UN | Carolina bays |
| Florida false loosestrife[c] | NL | UN | Carolina bays |
| Gaura | NL | UN | Stream banks, meadows, and roadsides |
| Green-fringed orchid[c] | NL | SL | Carolina bays, bottomland hardwoods |
| Little bur-head | NL | SL | Carolina bays |
| Nestronia | C2 | NL | Upland woodlands |
| Quill-leaved swamp potato | NL | SL | Carolina bays |
| Smooth purple coneflower | E | NC | Open woodlands, roadbanks |
| Swamp lobelia | C2 | NL | Carolina bays |
| Trepocarpus | NL | UN | Bottomland hardwoods |
| Yellow cress | NL | UN | Bottomland hardwoods |
| Yellow wild indigo | NL | UN | Pine forests, open woods |

[a] Status code: C2 - candidate, Category 2 (possibly appropriate to list); E - endangered; NC -national, of concern (plant); NL - not listed; SC - state, of concern (animals); SE - state, endangered (animals); SL - state, of concern (plants); T - threatened; UN - undetermined.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur near Rainbow Bay adjacent to proposed TSS.

[d] Species occurs in discharge receiving areas.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; 56 FR 64229; DOE 1992e; SR NERP 1990b; SR WMRD 1991a; SR WMRD 1992a; SR WMRD 1992b; WSRC 1989e; WSRC 1993b.

Approximately 400 historic sites have been identified within the SRS; approximately 10 percent have been evaluated for NRHP eligibility. Of these, 10 historic sites have been determined NRHP-eligible.

Most historic structures were demolished during the initial establishment of SRS in 1951. Two 1951 buildings, including the Hector Reactor, are currently in use. The existing nuclear production facilities are not likely to be considered NRHP-eligible because they may lack architectural integrity, may not be representative of a particular style, and may not be contributing features to the broad theme of the Manhattan Project and initial nuclear production.

At the proposed TSS, five historic sites and two historic sites with prehistoric components have been recorded. Six sites are late 19th to early 20th century farmsteads. Three sites have been determined NRHP-eligible because they contribute pertinent information to postbellum socioeconomic history (SRARP 1989a:81).

**Native American Resources.** Native American groups with traditional ties to the area include the Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. At different times, each of these Native American groups was encouraged by the English to settle in the area in order to provide protection from the French, Spanish, or other Native American groups. Main villages of both the Cherokee and Creek were located southwest and northwest of SRS, but both groups may have used the area for hunting and gathering activities. During the early 1800's, most of the remaining Native Americans residing in the region were relocated to the Oklahoma territory.

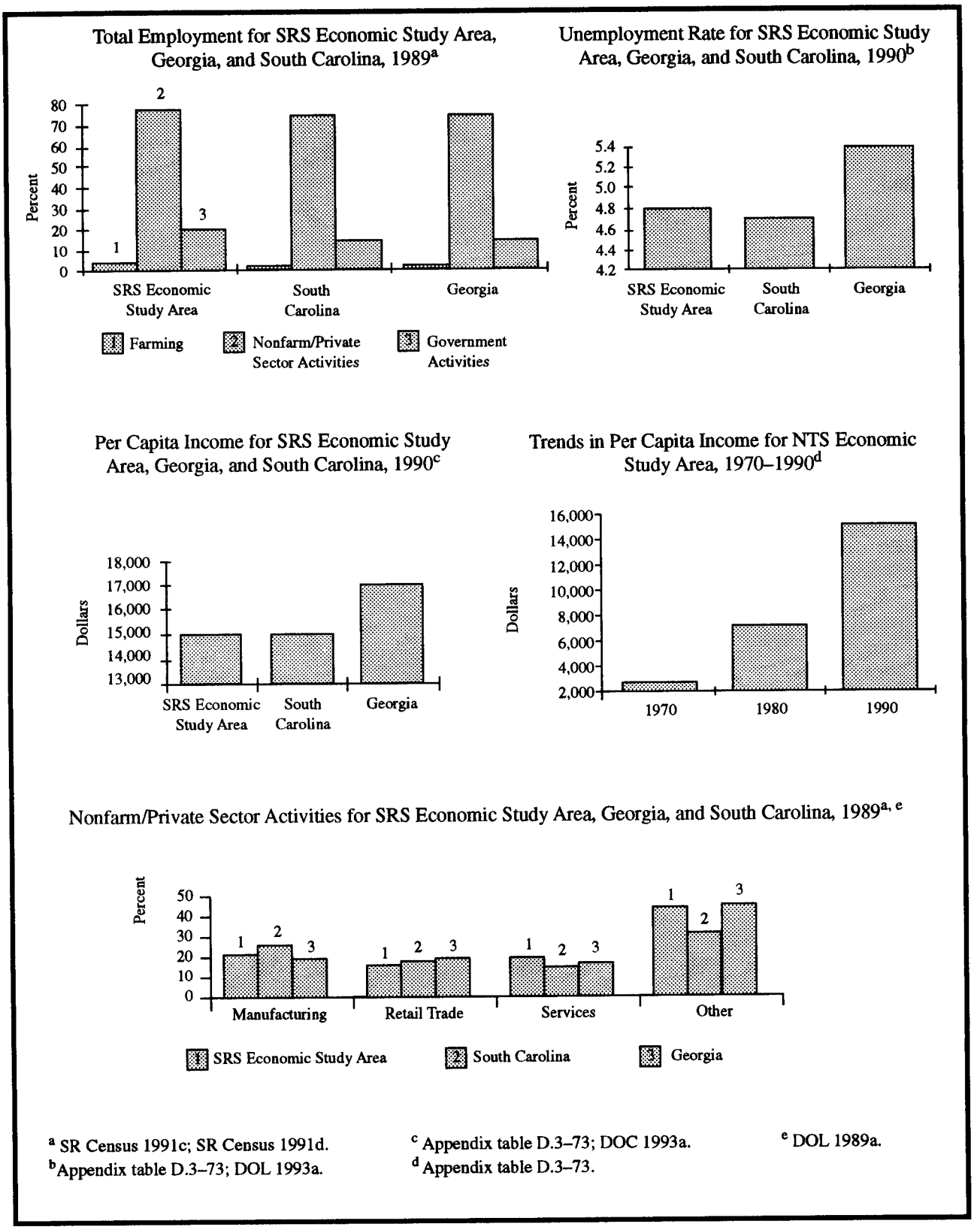
Native American resources in the region include villages or townsites, ceremonial lodges, burials, cemeteries, and areas containing traditional plants used for certain rituals. Literature reviews and consultations with Native American representatives reveal that there are some concerns related to the *American Indian Religious Freedom Act* within the central Savannah River valley; however, no specific sites at SRS have been identified. The Yuchi Tribal Organization, the National Council of the Muskogee Creek, the Indian People's Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, the Ma Chis Lower Alabama Creek Indian Tribe, and the United Keetoowah Band of the Cherokees have expressed concerns for sensitive Native American resources at SRS. The Yuchi and the Muskogee Creek expressed concern for areas containing several plants traditionally used in ceremonies (SR DOE 1991e:19,21).

**Paleontological Resources.** Paleontological materials at SRS include: fossil plants, numerous invertebrate fossils, deposits of giant oysters (*Crassostrea gigantissima*), mollusks, and bryozoa. All paleontological materials from SRS are marine invertebrate deposits and, with the exception of the giant oysters, are relatively common fossils and are widespread; therefore, the assemblages have relatively low research potential.

#### 4.6.2.8 *Socioeconomics*

Socioeconomic characteristics addressed at SRS include employment and local economy, population, housing, public finance, and local transportation. Statistics for employment and local economy are based on the economic study area that encompasses 26 counties around SRS. The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for the remaining socioeconomic characteristics are based on the ROI, a 4-county area in which 87 percent of all SRS employees reside: Aiken County (52 percent) and Barnwell County (7 percent) in the State of South Carolina; and Columbia County (11 percent) and Richmond County (17 percent) in the State of Georgia. (See figure 4.6–1 for a map of counties and cities.) Fiscal characteristics of the jurisdictions in the ROI are presented in the public finance section in appendix tables D.3–79 and D.3–80. The school districts most likely to be affected by the proposed action include those in Aiken, Columbia, and Richmond counties and Barnwell County Districts 19, 29, and 45. Assumptions, assessment methodologies, and supporting data are presented in appendix D.

**Employment and Local Economy.** Employment and local economy statistics for the economic study area are given in appendix table D.3–73 and summarized in figure 4.6.2.8–1. Between 1970 and 1990, the civilian labor force in the economic study area increased 86 percent. The unemployment rate in the economic study area in 1990 was slightly higher than




[a] SR Census 1991c; SR Census 1991d.
[b] Appendix table D.3–73; DOL 1993a.
[c] Appendix table D.3–73; DOC 1993a.
[d] Appendix table D.3–73.
[e] DOL 1989a.

**FIGURE 4.6.2.8–1.—*Economy for Savannah River Site Economic Study Area.***

the economic study area was the same as that of the State of South Carolina but 12 percent below the State of Georgia per capita income.

As shown in figure 4.6.2.8-1, the percentage of total employment involving farming in the economic study area was double the percent for the States of South Carolina and Georgia. The percentage in governmental activities was 25 percent higher. Nonfarm private sector activities of manufacturing, retail trade, and services were similar in the economic study area and the two states, except that manufacturing in the State of South Carolina represented a 20 percent larger share than in either the economic study area or the State of Georgia.

In 1990, SRS employed 22,290 persons (4.6 percent of the total economic study area employment), increasing from 5,737 persons in 1970. Historical and future employment at SRS and the distribution of SRS employees by place of residence in the ROI are presented in appendix tables D.2.1–1 and D.3–72, respectively.

**Population and Housing.** Population and housing distribution in the ROI is presented in appendix tables D.3–75 and D.3–77 and summarized in figure 4.6.2.8–2. The percentage increase in population in the ROI from 1970 to 1990 was similar to the States of South Carolina and Georgia except for Columbia County which experienced a 196-percent increase. With the exception of two counties, the percentage increase in housing units between 1970 and 1990 was similar to or just below the percentage increase for the two states. Columbia County experienced a 252-percent increase which is higher than the percentage increase for the two states. Conversely, Barnwell County experienced a 2-percent increase which is lower than the percentage increase for the two states. Homeowner and rental vacancy rates in the ROI in 1990 were similar to these experienced by the States of South Carolina and Georgia.

**Public Finance.** Financial characteristics of the local jurisdictions in the ROI that are most likely to be affected by the proposed action include total revenues and expenditures of each jurisdiction's general fund, special revenue funds, and, as applicable, debt service, capitol project, and expendable trust funds. School district boundaries may or may not coincide with county or city boundaries, but the districts are presented under the county where they primarily provide services. Major revenue and expenditure fund categories for counties, cities, and school districts are presented in appendix tables D.3–79 and D.3–80, and figure 4.6.2.8–3 summarizes local government's revenues less its expenditures.

**Local Transportation.** SRS is served by more than 200 miles of primary roads and more than 1,000 miles of unpaved secondary roads. The primary highways used by SRS commuters are State Routes 19, 64, and 125; 40, 10, and 50 percent of the workers use these routes, respectively (figure 4.6–1). Significant congestion occurs during peak traffic periods onsite on Road 1-A and on State Routes 19 and 125 and U.S. Route 278 at SRS access points (Wilbur Smith Associates 1989). Long delays are also experienced offsite along Interstate 20 and U.S. Routes 1 and 25 where they cross the Savannah River. SRS is currently implementing changes to remedy the congestion at some access points.

Rail service in the ROI is provided by the Norfolk Southern Corporation and CSX Transportation. SRS is provided rail access via Robbins Station on the CSX Transportation line. In addition, SRS maintains 50 miles of onsite track for internal uses (WSRC 1990c).

Waterborne transportation is available via the Savannah River. Currently, the Savannah River is used primarily for recreation (WSRC 1990c). No commercial waterborne vessel docking facilities exist at SRS.

Columbia Metropolitan Airport in the city of Columbia and Bush Field in the city of Augusta receive jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located in the ROI (DOT 1991a).

#### 4.6.2.9 *Radiation and Hazardous Chemical Environment*

The following provides a description of the radiation and hazardous chemical environment at SRS. Also included are discussions of health effects studies, emergency preparedness considerations, and an accident history.

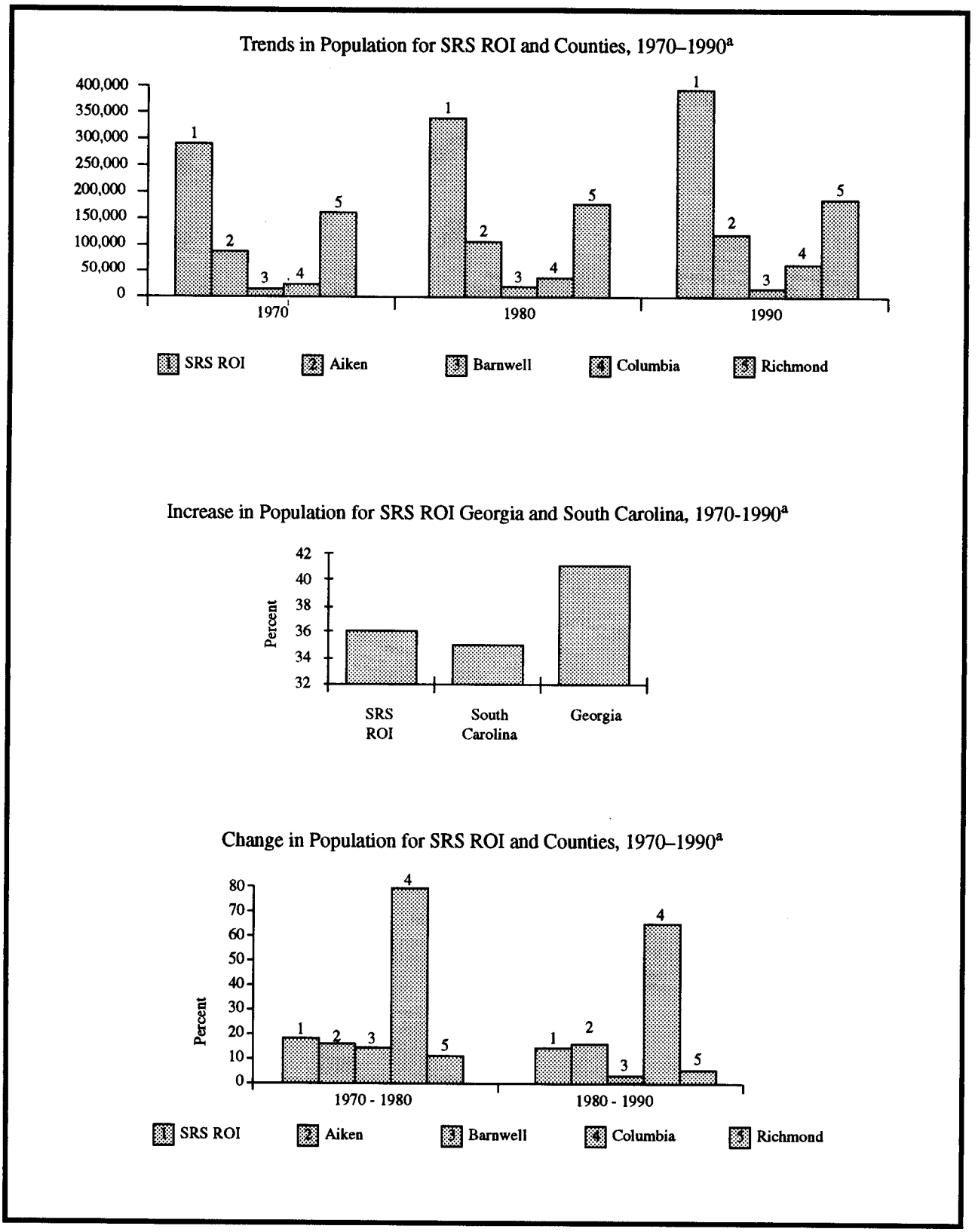
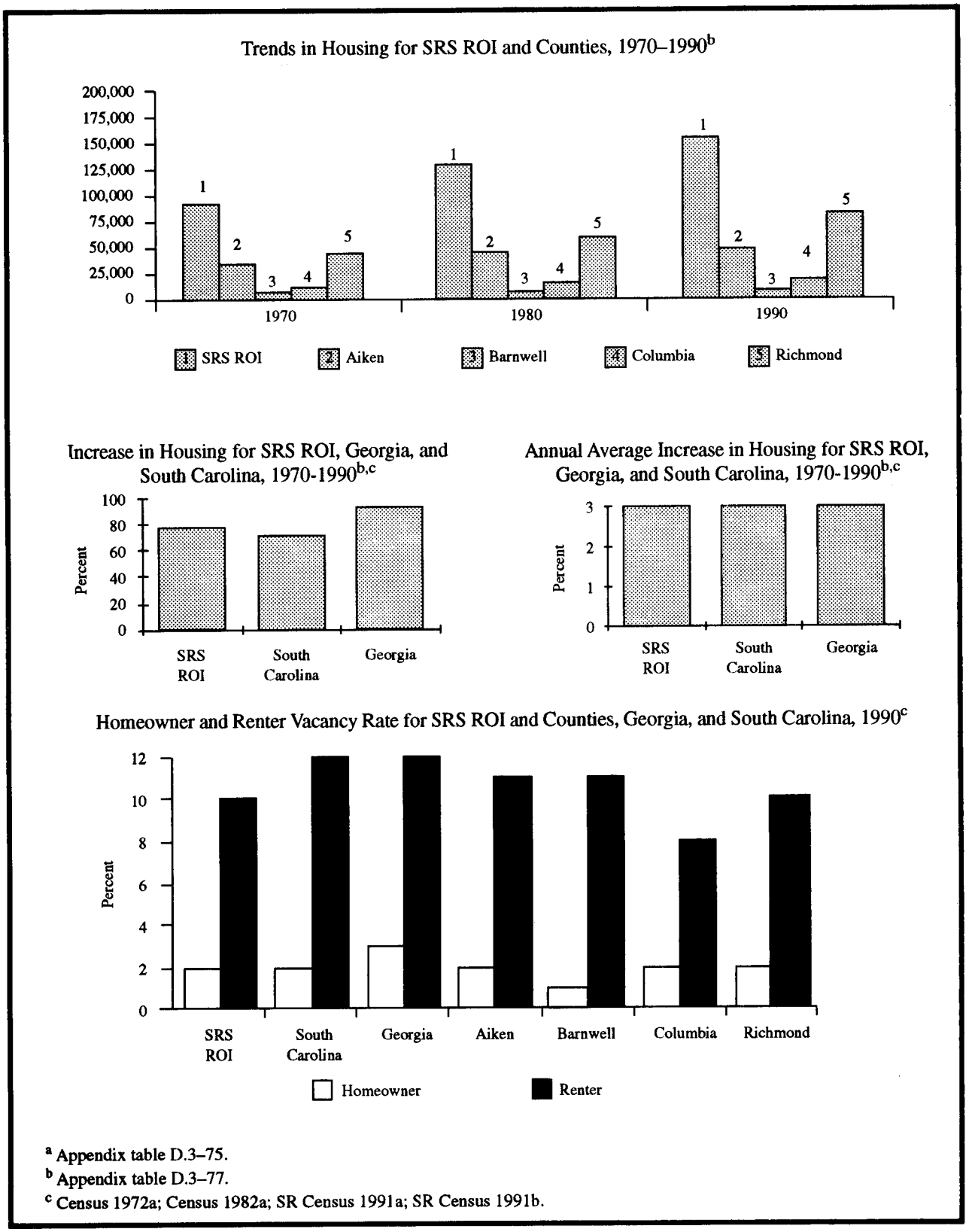
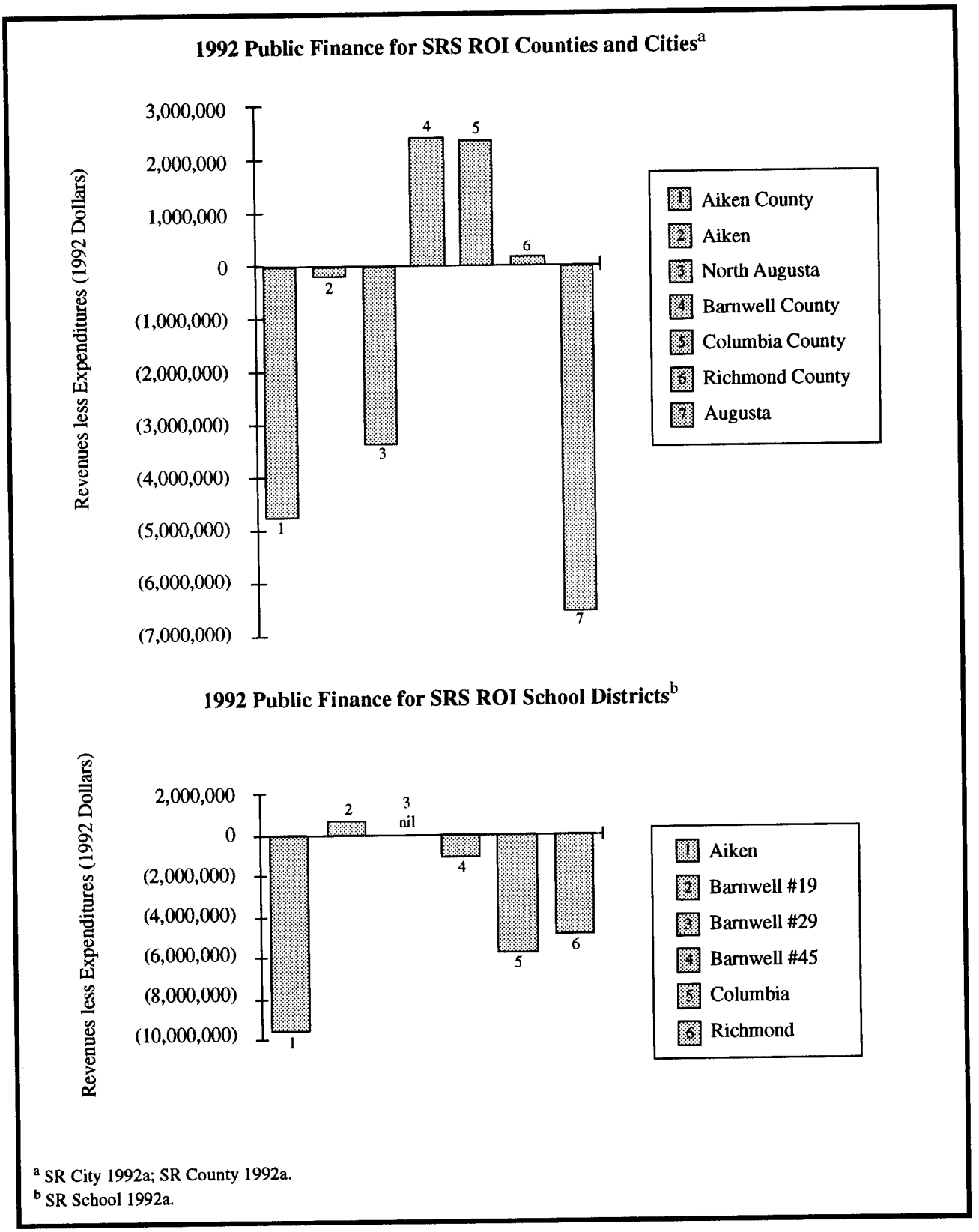



**FIGURE 4.6.2.8–2.—*Population and Housing for Savannah River Site Region-of-Influence* [Page 1 of 2].**




[a] Appendix table D.3–75.
[b] Appendix table D.3–77.
[c] Census 1972a; Census 1982a; SR Census 1991a; SR Census 1991b.

**FIGURE 4.6.2.8–2.—*Population and Housing for Savannah River Site Region-of-Influence* [Page 2 of 2].**




[a] SR City 1992a; SR County 1992a.
[b] SR School 1992a.

**FIGURE 4.6.2.8–3.**—***1992 Local Government Public Finance for Savannah River Site Region-of-Influence.***

**Radiation Environment.** Major sources of background radiation exposure to individuals in the vicinity of SRS are shown in table 4.6.2.9–1. All annual doses to individuals from background radiation are expected to remain constant over time. Accordingly, the incremental total dose to the population would result only from changes in the size of the population. Background radiation doses are unrelated to SRS operations.

**TABLE 4.6.2.9–1.—*Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Savannah River Site Operations***

| Source | Committed Effective Dose Equivalent (mrem/yr) |
|---|---|
| **Natural Background Radiation**[a] | |
| Cosmic and cosmogenic radiation | 33 |
| External terrestrial radiation | 43 |
| Internal terrestrial radiation | 39 |
| Radon in homes (inhaled) | 200 |
| **Other Background Radiation**[b] | |
| Diagnostic X-rays and nuclear medicine | 53 |
| Weapons test fallout | <1 |
| Air travel | 1 |
| Consumer and industrial products | 10 |
| **Total** | 380 |

[a] From WSRC 1993a. Value for radon is an average for the United States.
[b] From NCRP 1987a.

Releases of radionuclides to the environment from SRS operations provide another source of radiation exposure to individuals in the vicinity of SRS. The radionuclides and quantities released from SRS operations in 1992 are listed in the *Savannah River Site Environmental Report for 1992* (WSRC-TR-93-075). The doses to the public resulting from these releases are presented in table 4.6.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1992 report were used in the development of the reference environment (No Action) radiological releases at SRS in the year 2010 (section 4.6.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (appendix section E.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from SRS operations in 1992 is estimated to be approximately $1.4 \times 10^{-7}$. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of SRS operations is less than 2 chances in 10 million. (Note that it takes several to many years from the time of exposure to radiation for a cancer to manifest itself.)

Approximately $4.5 \times 10^{-3}$ excess fatal cancers were estimated from normal operations in 1992 to the population living within 50 miles of SRS. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate, associated with cancer, for the entire U.S. population was 0.2 percent per year (Almanac 1993a). Based on this national mortality rate, the number of fatal cancers from all causes expected during 1992 in the population living within 50 miles of SRS was 1,240. This number of expected fatal cancers is much higher than the estimated $4.5 \times 10^{-3}$ fatal cancers that could result from SRS operations in 1992.

Workers at SRS receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 4.6.2.9–3 includes the average, maximum, and total occupational doses to SRS workers from operations in 1992. These doses fall within radiological limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (appendix section E.2), the number of excess fatal cancers to SRS workers from operations in 1992 is estimated to be 0.14.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Savannah River Site Environmental Report for 1992* (WSRC-TR-93-075). The concentrations of radioactivity in various environmental media (e.g., air, water, soil) in the site region (onsite and offsite) are also presented in this reference.

**Chemical Environment.** The background chemical environment important to human health consists of: the atmosphere, which may contain toxic chemicals that can be inhaled; drinking water, which may

**TABLE 4.6.2.9–2.—*Doses to the General Public from Normal Operations at Savannah River Site, 1992 (committed effective dose equivalent)***

| | Atmospheric Releases | | Liquid Releases | | Total | |
|---|---|---|---|---|---|---|
| **Affected Environment[a]** | **Standard[b]** | **Actual** | **Standard[b]** | **Actual[c]** | **Standard[b]** | **Actual** |
| Maximally exposed individual (mrem) | 10 | 0.14 | 4 | 0.13 | 100 | 0.27 |
| Population within 50 miles[d] (person-rem) | None | 6.4 | None | 2.5 | 100 | 8.9 |
| Average individual within 50 miles[e] (mrem) | None | 0.010 | None | NA | None | 0.014 |

[a] From WSRC 1993a.
[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the *Clean Air Act*, the 4 mrem/yr limit is required by the *Safe Drinking Water Act*, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834. If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.
[c] The actual dose value given in the column under liquid releases conservatively includes all water pathways, not just the drinking water pathway. The population dose includes contributions to Savannah River users downstream of SRS to the Atlantic Ocean.
[d] In 1992, this population was approximately 620,100.
[e] Obtained by dividing the population dose by the number of people living within 50 miles of the site.
Note: NA - not applicable.

**TABLE 4.6.2.9–3.—*Doses to the Worker Onsite from Normal Operations at Savannah River Site, 1992 (committed effective dose equivalent)***

| | Onsite Releases and Direct Radiation | |
|---|---|---|
| **Affected Environment[a]** | **Standard[b]** | **Actual** |
| Average worker (mrem) | None | 17.9 |
| Maximally exposed worker (mrem) | 5,000 | 3,000 |
| Total workers (person-rem) | None | 350 |

[a] From DOE 1993. The number of badged workers in 1992 was approximately 19,500.
[b] From 10 CFR 835. DOE's goal is to maintain radiological exposures as low as reasonably achievable.

contain toxic chemicals that can be ingested; and other environmental media with which people may come in contact (e.g., surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in sections 4.6.2.3 and 4.6.2.4.

Health impacts to the public can be minimized through effective administrative and design controls for decreasing pollutant releases to the environment and achieving compliance with permit requirements (e.g., air emissions and NPDES permit requirements). The effectiveness of these controls is verified through the use of monitoring information, and inspection of mitigation measures. Health impacts to the public may occur during normal operations at SRS via inhalation of air containing pollutants released to the atmosphere by SRS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water, or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous/toxic air pollutants and their applicable standards are presented in section 4.6.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous/toxic chemicals is presented in appendix section E.3.

Health impacts to SRS workers during normal operation may include those from inhalation of the workplace atmosphere, drinking SRS potable water, and possible other contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and

from worker to worker, and available information is not sufficient to allow a detailed estimation and summation of these impacts. However, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. SRS workers are also protected by adherence to occupational standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Monitoring ensures that these standards are not exceeded. Additionally, DOE requirements (DOE Order 3790.1B) ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at SRS are expected to be substantially better than required by the standards.

**Health Effects Studies.** Two published epidemiological studies on the general population in communities surrounding SRS have been conducted. One study found no evidence of excess cancer mortality, whereas another study reported an excess in leukemia and lung cancer deaths along with other statistically nonsignificant excess deaths. An excess in leukemia deaths has been reported among hourly workers at SRS. For a more detailed description of the studies reviewed and the findings, refer to appendix section E.4.6

**Accident History.** Beginning in 1974 and continuing into 1988, there was a series of releases from the tritium facilities at SRS. These releases have been traced to aging equipment in the tritium processing facility and are one of the reasons for the construction of a replacement tritium facility at SRS. A detailed description and study of these incidents and their consequences to the offsite population has been documented by SRS. Between 1974 and 1988, there were 13 inadvertent tritium releases. The most significant were in 1981, 1984, and 1985 when 32,934, 43,800, and 19,403 Ci of tritiated water vapor, respectively, were released (WSRC 1991a). In the period 1989 through 1992 there were 20 inadvertent releases, all with little or no offsite dose consequences. The largest of these recent releases occurred in 1992 when 12,000 Ci of tritium were released (SRS 1993a:3).

In the event of an accident each DOE site has established an emergency management program. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response. Section 4.1.9 provides a description of DOE's emergency preparedness program.

The Emergency Preparedness Facility at SRS provides overall direction and control for onsite responses to emergencies and coordinates with Federal, state, and local agencies and officials on the technical aspects of the emergency.

The SRS Emergency Operations Facility consists of several centers, described below, that provide distinct emergency response support functions:

- The SRS Operations Center coordinates the initial response to all SRS emergencies and is equipped to function as the heart of SRS's emergency response communications network.

- The Technical Support Center provides command and control of emergency response activities for the affected facility or operational area.

- The Emergency Operations Center provides command and control of emergency response activities for SRS locations outside of the affected area.

- The Security Management Center coordinates activities relating to the security and safeguarding of materials by providing security staff in the affected area and contractor management in the Emergency Operations Center.

- The Dose Assessment Center is responsible for assessing the health and environmental consequences of any airborne or aqueous releases of radioactivity or toxic chemicals and recommends onsite and offsite protective actions to other centers.

### 4.6.2.10 *Waste Management*

This section outlines the major environmental regulatory structure and ongoing waste management activities for SRS. A more detailed discussion of the ongoing waste management operations is provided in appendix section H.2.5. Table 4.6.2.10–1 presents a summary of waste management at SRS for 1991.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

EPA has placed SRS on the NPL and has identified approximately 150 potential operable units. In accordance with CERCLA, DOE entered into a Federal Facility Agreement with the EPA and the State of South Carolina, effective January 15, 1993, to coordinate cleanup activities at SRS under one comprehensive strategy. The Federal Facilities Agreement combines the RCRA Facility Investigation Program Plan under RCRA with a CERCLA cleanup program entitled the RCRA Facility Investigation Remedial Investigation Program Plan.

SRS generates and manages spent nuclear fuel and the following waste categories: HLW, TRU, LLW, mixed, hazardous, and nonhazardous. SRS has an aggressive waste minimization program in progress to vastly improve the operation of existing and planned liquid and solid waste generating, treatment, and storage facilities. A disciplined approach to these activities is being developed based on technology and experience from the commercial nuclear industry. This approach already has reduced the generation of TRU waste (48 percent), LLW (13 percent), mixed waste (96 percent), and hazardous wastes (58 percent) (DOE 1993e:I-18). A discussion of the waste management operations associated with each of these categories follows.

**Spent Nuclear Fuel.** On April 29, 1992, DOE decided to discontinue reprocessing spent nuclear fuel solely to recover fissile and fertile materials. After the completion of several ongoing programmatic and site-specific reviews pursuant to the *National Environment Policy Act*, DOE will make decisions concerning the treatment and stabilization of the current SRS inventory of spent nuclear fuel, and the use and subsequent decontamination and decommissioning of both the F- and H-Canyons facilities. With the shutdown of the K- and L-Reactors at SRS, no new spent fuel is expected to be generated in the future from existing SRS operations. However, SRS may continue to receive spent fuel from offsite facilities, and treat and stabilize that fuel for long-term storage. Decisions concerning future receipt and management of spent nuclear fuel at SRS will be made in accordance with the RODs from both the *Department of Energy Programmatic Spent Nuclear Fuel Management* and *INEL Environmental Restoration and Waste Management Programs EIS*, and the EIS on the *Proposed Policy for the Acceptance of U.S. Origin Foreign Research Reactor Spent Nuclear Fuel.*

**High-Level Waste.** Liquid HLW at SRS is made up of many waste streams generated during the recovery and purification of transuranic products and unburned fissile material from spent reactor fuel elements. These wastes are treated prior to their transfer to underground tanks in F- and H-Area Canyons where they are separated by waste form, radionuclide and heat content. Processes that treat liquid HLW routinely are separation, evaporation and ion exchange. Cesium is removed from the condensate prior to transfer to the Effluent Treatment Facility where the concentrate is treated as low-level process wastewater. The decontaminated salt solution resulting from the in-tank precipitation process is sent with residues from the Effluent Treatment Facility to the Defense Waste Processing Z-Area Saltstone Facility where it is mixed with a blend of cement, flyash, and blast furnace slag to form a low-level grout. The grout is pumped into disposal vaults where it hardens for permanent disposal. The remaining high-level salt is precipitated and the precipitate and high-level sludge will be permanently immobilized as a glass solid cast in stainless steel containers at the Defense Waste Processing Facility Vitrification Plant. The stainless-steel containers will be decontaminated to

TABLE 4.6.2.10–1.—*Current Spent Nuclear Fuel and Waste Management at Savannah River Site* [Page 1 of 2]

| Category | 1991 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | None | None | Pools | Sized to current inventory | None–eventually, repository | NA |
| **High-Level** | | | | | | | |
| Liquid | 4,715 (952,508 gal) | Settle, store, separate, evaporate | 76,250 (15,398,000 GPY) | F &H Area Tank Farm | 308,000 (62,200,000 gal) | NA | NA |
| Solid | None | NA | NA | NA | NA | NA | NA |
| **Transuranic** | | | | | | | |
| Liquid | None | NA | NA | NA | NA | NA | NA |
| Solid | 1,804 | None | None | Pads, buildings | 26,513 | None–Federal repository in the future | None |
| **Low-Level** | | | | | | | |
| Liquid | 99,500 (20,092,000 gal) | Adsorption, evaporation, filtration, neutralization, saltstone | 3,924,000 (792,700,000 GPY) | Ponds, tanks-awaiting processing | NA | NA | NA |
| Solid | 31,113 | Compaction | 73,250 | NA | NA | Trench, caissons | 1,400,000 |
| **Mixed Low-Level** | | | | | | | |
| Liquid | 1,366 (275,900 gal) | Stabilization, adsorption, neutralization, precipitation, filtration, ion exchange, evaporation | 76,700 (15,500,000 GPY) | RCRA permit Bldgs. E, 600, 700 | Included in solid | None | None |
| Solid | 37 | None | NA | RCRA permit Bldg. 600 | 1,519 | None | None |
| **Hazardous** | | | | | | | |
| Liquid | Included in solid | None | None | DOT containers | Included in solid | Offsite | NA |
| Solid | 115 | None | None | DOT containers | 7,300 | Offsite | NA |

TABLE 4.6.2.10–1.—*Current Spent Nuclear Fuel and Waste Management at Savannah River Site* [Page 2 of 2]

| Category | 1991 Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 915,841 (185,000 gal) | Filter, settle, strip | 1,300,000 (265,000,000 GPY) | Flowing ponds | NA | Permitted discharge | Varies by each permitted outfall |
| Solid | 111,518 | Compaction—reduces volume to 27,900 $yd^3$ for disposal | Expandable, as required | NA | NA | Landfill (onsite) offsite disposal is being investigated | Expandable, as required |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |

Source: DOE 1992f; DOE 1993g; SR MMES 1993a.

DOT standards, welded closed, and temporarily stored onsite for eventual transport to and disposal in a permanent Federal repository. Once the current inventory of spent nuclear fuel in the F- and H-Canyons is processed, no new HLW is expected to be generated.

**Transuranic Waste.** Under the Federal Facility Compliance Agreement on RCRA land disposal restrictions signed by EPA and DOE on March 13, 1991, SRS is required to prepare TRU waste for shipment. SRS will continue storing certified TRU waste at the TRU waste storage pads until it can be shipped to WIPP once that facility can demonstrate compliance with the requirements of 40 CFR 191 and 40 CFR 268 or to another TRU waste disposal facility should WIPP prove unsatisfactory. Should additional treatment be necessary for disposal at WIPP, SRS would develop the appropriate treatment capability. This agreement, which must be modified if DOE determines that no TRU waste will be shipped from SRS by July 30, 1999, should form the basis for the site-specific treatment plan required of all DOE facilities storing mixed wastes by the *Federal Facility Compliance Act* of 1992. All TRU waste currently generated is stored in containers on aboveground pads. Since April 1986, newly-generated TRU waste has been received at the Experimental TRU Waste Assay Facility where the drums are weighed and assayed to determine whether the waste is contaminated to a level greater than 100 nCi/g and to determine other information required by the current WIPP waste acceptance criteria. Drums certified for shipment to WIPP are placed in interim storage on concrete pads in E-Area pending startup of WIPP. Drums that contain less than 100 nCi/g are segregated and are eventually sent to LLW disposal (<10 nCi/g) or managed as TRU waste until performance modeling and waste acceptance criteria for onsite disposal have been finalized (if >10 nCi/g and <100 nCi/g).

The TRU Waste Facility is scheduled to begin waste retrieval operations in 1994. The TRU Waste Facility will retrieve and process existing retrievable stored TRU waste and prepare it for certification and permanent disposal at WIPP or disposal onsite as LLW. Because all of the TRU waste placed on the aboveground pads prior to January 1990 is suspected of having hazardous constituents, a RCRA Part B permit application has been submitted for the TRU waste storage pads and the Experimental TRU Waste Assay Facility/Waste Certification Facility. The waste is currently being stored under RCRA interim status/regulations.

**Low-Level Waste.** The bulk of liquid LLW is aqueous process waste including effluent cooling water, purge water, water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination. Liquids are processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points within standards established by the terms of the regulatory permit. Solid LLW which is routinely handled includes operating and laboratory waste, contaminated equipment, reactor and reactor fuel hardware, spent lithium-aluminum targets, and spent deionizer resin from reactor basins. Solid LLW is separated by radiation levels into low and intermediate categories. Solid LLW that radiates less than 200 mrem/hr at 5 cm from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem/hr at 5 cm, it is considered intermediate-activity waste. Intermediate activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. The primary disposal mode for solid LLW is burial in engineered earthen trenches. Saltstone generated in the solidification of decontaminated salts extracted from HLW is disposed of as LLW in a separate facility in enclosed vaults. In 1993, disposal of LLW began in a 100-acre site expansion in the north portion of E-Area. This disposal facility is projected to meet solid LLW storage/requirements to include LLW from DOE offsite facilities such as Pinellas for the next 20 years.

**Mixed Low-Level Waste.** The Federal Facility Compliance Agreement signed by EPA and DOE on March 13, 1991, addresses SRS compliance with RCRA land disposal restrictions pertaining to past, ongoing, and future generation of mixed LLW (mostly solvents, dioxin, and California list wastes contaminated with tritium). SRS is allowed to continue to operate, generate, and store mixed wastes subject to land disposal restrictions; however, in return, SRS will report to EPA the characterization of all solid waste streams disposed of in land disposal units at SRS and will submit a plan for waste minimization to EPA for review. Schedules for measures to

provide compliance through construction of the Consolidated Incineration Facility (scheduled to start operation in 1995) and the Hazardous Waste/Mixed Waste Storage Facility are included in this agreement.

The Consolidated Incineration Facility will treat mixed LLW and liquid hazardous waste. The hazardous waste/mixed waste disposal vaults are scheduled to be available in late 1996. Mixed waste is currently placed in interim storage in the E-Area solid waste disposal facility and in two buildings in G-Area. These RCRA-permitted facilities will be used until completion of the Consolidated Incineration Facility and the Hazardous Waste/Mixed Waste Storage Facility. *The Federal Facility Compliance Act* of 1992 requires DOE facilities storing mixed wastes to develop site-specific treatment plans and to submit the plans for approval. The requirements of the Federal Facility Compliance Agreement are summarized in appendix section A.1.5, and would form the basis for the SRS site-specific plan. South Carolina has the option to waive development of a site-specific plan by becoming a signatory to the existing Federal Facility Compliance Agreement.

**Hazardous Waste.** Lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents are typical hazardous wastes generated at SRS. Unlike most other DOE facilities, SRS is presently constructing and plans to construct hazardous waste treatment and disposal facilities onsite. All hazardous wastes are stored in RCRA and DOT-approved containers onsite in RCRA-permitted facilities in the 700-Area. To allow the site to maintain its current storage capabilities, some of the waste is shipped offsite to commercial RCRA-permitted treatment and disposal facilities using DOT-certified transporters. A Hazardous/Mixed Waste Disposal Facility that will employ a variety of treatment processes should be completed by 2004 to treat, store, and dispose of hazardous and mixed wastes that cannot be managed at existing or other planned facilities.

**Nonhazardous Waste.** Twenty wastewater treatment plants are operated in 13 SRS operations production areas. A new centralized sanitary wastewater collection and treatment facility is required by the settlement agreement signed on February 27, 1990, and became operational in 1994. This facility includes a primary sanitary sewer collection system, a central sanitary wastewater treatment facility, and ultraviolet disinfection systems for the remaining facilities in D-, K-, L-, P-, and TNX-Areas. SRS wastewater is currently treated at small package plants by the extended aeration process. The wastewater treatment plant effluent is disinfected by liquid sodium hypochlorite addition. The solid sludge is disposed of in the SRS-operated sanitary landfill. The existing landfill site has documented groundwater contamination and is currently operating under an expired state permit. The state has not reissued the permit but continues to allow SRS to operate under the conditions of the expired permit. The landfill is divided into three sections: (1) the original landfill, (2) the southern expansion, and (3) the northern expansion. The original landfill and the southern expansion have reached their capacity. If current generation rates continue, the northern expansion is expected to provide capability until 1997. The northern expansion will cease operations when a an offsite permitted commercial waste disposal facility and contractor is selected.

### 4.6.3 Environmental Impacts

This section describes the environmental impacts of constructing and operating various tritium supply technologies and upgraded recycling facilities at SRS which are described in sections 3.4.2 and 3.4.3. It begins by describing potential impacts to existing and planned facilities at SRS, followed by descriptions of potential impacts and the environmental impacts of the proposed action on potentially affected environmental resources. The section concludes by describing the potential impacts of tritium supply and recycling on human health during normal operation, the consequences of facility accidents, and regulatory considerations and waste management. Each description addresses the effects of No Action and the potential impacts and environmental impacts of constructing and operating both a tritium supply facility and an upgraded recycling facility at SRS.

#### 4.6.3.1 *Land Resources*

Construction and operation of a tritium supply facility and upgraded recycling facilities at SRS would affect land resources, including land use and visual resources. Potential impacts to these resources are summarized below.

SRS has sufficient land area to accommodate any of the proposed tritium supply technologies. New facilities would be located in the designated 600-acre TSS, surrounded by a 1-mile-wide buffer, all within the SRS boundary. The TSS would be located in the central portion of SRS, near other onsite areas of industrial land use (figure 4.6.2.1–1). The land is undeveloped and designated for industrial use. Tritium supply facilities are not expected to be visible from viewpoints with high levels of sensitivity; however, vapor plumes from cooling towers would result in additional visual impacts. The tritium recycling mission would continue in upgraded existing facilities located in H-Area (figure 4.6.2.1–1). The following sections present the effects of the proposed action on land resources.

**Land Use.**

*No Action.* Under No Action, DOE would continue existing and planned land use activities at SRS. The K-Reactor would remain in cold standby with no provision for restart, and the F- and H-Canyon operations would eventually be shut down; however, these facilities would remain in place until turned over to environmental management for disposition. Any impacts to land use from environmental management actions would be independent of and unaffected by this proposed action.

*Tritium Supply.* Any one of the tritium supply technologies (section 3.4.2) could be sited at SRS in the proposed TSS (figure 4.6.2.1–1). Land requirements for the tritium supply technologies are presented in table 4.6.3.1–1. As shown in the table, adequate undeveloped land exists. Prime farmland, agricultural activities, or special National Environmental Research Parks study areas would not be affected. Construction and operation of these facilities would be consistent with SRS future land use plans. The only impact would be the use of undeveloped SRS land. Land requirements would be largest for the MHTGR and least for the APT.

**TABLE 4.6.3.1–1.—*Potential Changes to Land Use Resulting from Tritium Supply Technologies and Recycling at Savannah River Site***

| | Tritium Supply Technologies | | | | |
|---|---|---|---|---|---|
| **Indicator** | **HWR** | **MHTGR** | **ALWR[a]** | **APT[b]** | **Tritium Recycling Upgrade** |
| Land requirements[c] (acres) | 260 | 360 | 350 | 173 | 0 |
| Available land[d,e] (percent) | 0.1 | 0.2 | 0.2 | 0.1 | 0 |

[a] Land requirements for both Large and Small ALWR are the same.
[b] Land requirement for both Phased and Full APT are the same.
[c] Land area requirements are estimated to be the same for construction and operation. Tritium extraction included in tritium supply.
[d] Undeveloped land is approximately 191,000 acres.
[e] Any land requirement less than 100 percent means sufficient land.
Source: DOE 1994a; FDI 1993d; FDI 1994a; FDI 1994b; SNL 1993a; SR DOE 1991b.

No tritium facilities would be constructed offsite, and offsite land use would not be directly affected. Offsite land is available and could be converted to residential developments to house workers. Such development would be subject to local land use controls and zoning ordinances, which vary by jurisdiction.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR, or ALWR at reduced capacity to meet a tritium supply requirement less than baseline, or the construction and operation of a Phased APT would not change potential baseline tritium requirement land use impacts described above. Land requirements would be the same in both operation scenarios.

*Tritium Recycling Upgrade.* Upgrade of existing tritium recycling facilities would not result in any additional land disturbance; therefore, there would be no land use impacts.

*Tritium Recycling Phaseout.* In the event the tritium supply technology is collocated with a new tritium recycling facility at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. It is anticipated that the existing tritium recycling facilities would remain in place following phaseout; therefore, no onsite impacts to land use are expected.

*Potential Mitigation Measures.* No mitigation measures are proposed.

**Visual Resources.**

*No Action.* Under No Action, no new construction or demolition activities are anticipated that would result in a VRM classification change. The existing SRS landscape character would still range from VRM Class 3 to VRM Class 5 (higher to lower aesthetic value).

*Tritium Supply.* Views of the construction and operation of the HWR, MHTGR, and ALWR would be similar to other large industrial facilities at SRS. Views of the APT construction and operation would be much less obtrusive because most of the facility has a lower profile than other technologies due to its low profile cooling system. Construction of any tritium supply facility would change the VRM classification from Class 4 to Class 5 at the TSS. The proposed TSS would be approximately 4 miles from State Highway 125, the nearest public access points with a high sensitivity level. Views from this roadway would be blocked by heavy vegetation, forested areas, and terrain. Therefore, construction and operation of the proposed facilities would not attract the attention of the average observer and visual impacts would be minimal. There would be no change in the overall appearance of SRS from key viewpoints with high sensitivity levels. The use of an evaporative cooling system on the HWR, MHTGR, or ALWR would potentially result in large cooling towers (up to 50 stories high) and visible plumes during certain atmospheric conditions. The cooling system of the APT would have no visible plume.

*Less Than Baseline Operations.* Baseline visual impacts would not change due to operation of the HWR, MHTGR, or ALWR at reduced tritium capacity or the construction and operation of a Phased APT.

*Tritium Recycling Upgrade.* Because no new facilities would be constructed to upgrade the existing tritium recycling mission no visual impacts would be anticipated.

*Tritium Recycling Phaseout.* The existing tritium recycling facilities would remain in place following phaseout. There would be no change in the existing landscape character; therefore, no impacts to visual resources are expected.

*Potential Mitigation Measures.* The use of alternative cooling systems (such as low-profile cooling towers or mechanical draft dry cooling towers) would reduce the visual impacts caused by vapor plumes from the HWR, MHTGR, or ALWR. The selection of a specific cooling system would be evaluated in site-specific tiered NEPA documents.

#### 4.6.3.2 *Site Infrastructure*

This section discusses the site infrastructure for No Action and the modifications needed for actions due to construction and operation of a new tritium supply facility as well as upgrade and phaseout of the existing tritium recycling facility. With the exception of the APT, the SRS infrastructure would be capable of supporting any one of the proposed tritium supply

technologies without major modifications to the existing infrastructure. A comparison of site infrastructure and facilities resource needs for tritium supply and phaseout of the existing tritium recycling facilities is presented in table 4.6.3.2–1. The upgraded recycling facilities would require only a slight change of resource requirements above those of the current recycling facilities included in the No Action baseline. Therefore, the upgraded tritium recycling facilities operational data is not included separately in table 4.6.3.2–1, but is included in No Action.

**No Action.** The missions discussed in section 3.3.6 would continue under No Action. As shown in table 4.6.3.2–1, the site infrastructure would continue to adequately support the future missions to include tritium recycling. The shutdown of the F- and H-Canyons by 2005 would further reduce infrastructure needs.

**Tritium Supply and Recycling Facilities Upgrade.** The modification to the infrastructure at SRS to support the various tritium supply technologies are summarized in table 4.6.3.2–1. Adequate electrical energy is available from the regional power grid to accommodate each of the tritium supply technologies except the APT (table 4.6.3.2–2). The alternatives would require between 0.35 and 5.27 percent of the regional power pool capacity margin. For all technologies, the existing SRS transmission lines and facilities would need to be upgraded for the increased and redistributed electrical load.

Construction of approximately 6 miles of additional primary and secondary access roads and 6 miles of railroad right-of-way would be required for the HWR, MHTGR, and the ALWR. The APT would require an additional 3 miles of access road. Interconnection requirements are not expected to change appreciably when specific-site adaptations are completed.

The Unconsolidated Tritium Recycling Upgrade described in section 3.4.3.2 is designed to meet DOE Natural Phenomenon Hazard Requirements, affects five buildings, and is the one evaluated in this PEIS. These upgrades would basically involve the addition of wall bracing and cross bracing to beams, strengthening some exterior walls and reinforcing building frames.

**Tritium Recycling Facilities Phaseout.** Tritium recycling operations are currently performed in the H-Area in existing buildings. If SRS is selected as the site for a new tritium supply, tritium recycling would continue at SRS in upgraded facilities. However, if another site is selected to receive a new tritium supply with a collocated recycling facility, the tritium recycling functions at SRS would be phased out. As shown in table 4.6.3.2–1, this phaseout would have minimal impact on the site infrastructure.

**Less Than Baseline Operations.** In the event that only the steady state component of the baseline tritium requirement is required, the impacts on the site infrastructure would change for some technologies. There would be no appreciable change for the HWR, MHTGR, and ALWR technologies. The Phased APT would reduce electrical consumption by approximately 30 percent but the fuel, onsite transportation infrastructure, and power line requirements would not change.

**Potential Mitigation Measures.** The siting of a new tritium supply would not require infrastructure enhancements in most common support areas to mitigate environmental impacts. Siting of new roads, railroad spurs, and utility infrastructure could follow existing rights-of-way to minimize impacts to natural resources. Where new rights-of-way would need to be constructed, alignments should consider existing sensitive habitat (e.g., wetlands, streams, and vegetation) to minimize the potential for impacting these resources. As a potential mitigation measure, a consolidated tritium recycling upgrade which entails the relocation of all tritium processing and handling functions from Building 232-H to buildings 233-H and 234-H could be done. This would be in addition to the unconsolidated upgrade modifications except for Building 232-H. This upgrade would allow Building 232-H to be closed. While this consolidation would slightly increase construction resource requirements, it would result in decreases in some operational resources, manpower requirements, and tritium emissions and waste.

### 4.6.3.3 *Air Quality and Acoustics*

Construction and operation of a tritium supply technology and the upgrade of recycling facilities at SRS would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and

**TABLE 4.6.3.2–1.—*Modifications to Site Infrastructure for Tritium Supply Technologies and Recycling Phaseout at Savannah River Site***

| Alternative | Transportation | | Electrical | | Fuel | | |
|---|---|---|---|---|---|---|---|
| | Road (miles) | Railroad (miles) | Energy[a] (MWh/yr) | Peak Load (MWe) | Oil[b] (GPY) | Natural Gas (million ft$^3$/yr) | Coal (tons/yr) |
| **Current Resources** | 150 | 57 | 1,672,000 | 330 | 2,412,000 | 0 | 230,000 |
| **No Action** | | | | | | | |
| Total site requirement | 150 | 57 | 794,000 | 116 | 2,412,000 | 0 | 244,000 |
| Change from current resources | 0 | 0 | -878,000 | -214 | 0 | 0 | 14,000 |
| **Heavy Water Reactor** | | | | | | | |
| Total site requirement | 156 | 63 | 1,164,000 | 167 | 4,073,000 | 0 | 244,000 |
| Change from current resources | 6 | 6 | -508,000 | -163 | 1,661,000 | 0 | 14,000 |
| **Modular High Temperature Gas-Cooled Reactor** | | | | | | | |
| Total site requirement | 156 | 63 | 1,054,000 | 152 | 2,532,500 | 0 | 244,000 |
| Change from current resources | 6 | 6 | -618,000 | -178 | 120,500 | 0 | 14,000 |
| **Large Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 156 | 63 | 1,494,000 | 212 | 2,612,000 | 0 | 244,000 |
| Change from current resources | 6 | 6 | -178,000 | -118 | 200,000 | 0 | 14,000 |
| **Small Advanced Light Water Reactor** | | | | | | | |
| Total site requirement | 156 | 63 | 1,174,000 | 168 | 2,522,000 | 0 | 244,000 |
| Change from current resources | 6 | 6 | -498,000 | -162 | 110,000 | 0 | 14,000 |
| **Full Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 159 | 63 | 4,534,000 | 666 | 2,425,200 | 0 | 244,000 |
| Change from current resources | 9 | 6 | 2,862,000 | 336 | 13,200 | 0 | 14,000 |
| **Phased Accelerator Production of Tritium** | | | | | | | |
| Total site requirement | 159 | 63 | 3,194,000 | 471 | 2,425,200 | 0 | 244,000 |
| Change from current resources | 9 | 6 | 1,522,000 | 141 | 13,200 | 0 | 14,000 |
| **Recycling Facility Phaseout** | | | | | | | |
| Total site requirement | 150 | 57 | 770,000 | 113 | 2,352,000 | 0 | 238,800 |
| Change from current resources | 0 | 0 | -902,000 | -217 | -60,000 | 0 | 8,800 |

[a] The electrical energy available is greater than current usage (No Action).

[b] Oil is the primary utility fuel at SRS and all of the tritium supply natural gas requirements have been converted to oil equivalents: natural gas is assumed to be 1,000 British thermal units per ft$^3$, and fuel oil (8lb/gal) is assumed to be 19,000 British thermal units per lb.

Note: A negative number (-) indicates that sufficient resources exist to meet the demands.

Source: DOE 1995d; DOE 1995e; DOE 1995f; NERC 1993a; SNL 1995a; SR DOE 1995a.

**TABLE 4.6.3.2–2.—*Impacts on the Regional Electrical Power Pools from Tritium Supply Technologies at Savannah River Site***

| Tritium Supply Technology | Peak Power Required (MWe) | Capacity Margin (percent) | Annual Energy Required (MWh) | Total Electricity Production (percent) |
|---|---|---|---|---|
| Heavy Water Reactor | 51 | 0.49 | 370,000 | 0.14 |
| Modular High Temperature Gas-Cooled Reactor | 36 | 0.35 | 260,000 | 0.10 |
| Large Advanced Light Water Reactor | 96 | 0.92 | 700,000 | 0.27 |
| Small Advanced Light Water Reactor | 52 | 0.50 | 380,000 | 0.14 |
| Full Accelerator Production of Tritium | 550 | 5.27 | 3,740,000 | 1.37 |
| Phased Accelerator Production of Tritium | 355 | 3.40 | 2,400,000 | 0.88 |

Source: DOE 1995d; DOE 1995e; DOE 1995f; NERC 1993a; SNL 1995a; SR DOE 1995a.

state ambient air quality standards and guidelines. To determine the air quality impacts, criteria and toxic/hazardous concentrations from each technology have been compared with Federal and state standards and guidelines. Impacts for radiological airborne emissions are discussed in section 4.6.3.9.

In general, all of the proposed technologies would emit the same types of air pollutants during construction. Emissions would typically not exceed Federal, state, or local air quality regulations or guidelines, except that $PM_{10}$ concentrations may be close to or exceed the 24-hour standard during peak construction periods, which is not uncommon for large construction projects.

During operation, impacts from each of the tritium supply technologies with respect to the concentrations of criteria and toxic/hazardous air pollutants are predicted to be in compliance with Federal, state, and local air quality regulations or guidelines. The estimated pollutant concentrations presented in table 4.6.3.3–1 for each of the tritium supply technologies and upgrade of recycling facilities indicate little difference between technologies with respect to impacts to air quality.

The Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on the emission rates presented in appendix table B.1.4–5, Prevention of Significant Deterioration permits may be required for each of the proposed tritium supply technologies at SRS. This may require "offsets," reductions of existing emissions, to permit any additional or new emission source.

Noise emissions during either construction or operation are expected to be low. Air quality and acoustic impacts for each technology are described separately. Supporting data for the air quality and acoustics analysis, including modeling results, are presented in appendix B.

**Air Quality.** An analysis was conducted of the potential air quality impacts of emissions from each of the tritium supply technologies. The air quality modeling analysis used the Industrial Source Complex Short-Term model recommended by EPA. The resulting air quality conditions were then evaluated against local, state, air quality regulations, and NAAQS (40 CFR 50). Potential exceedance of Prevention of Significant Deterioration (40 CFR 52.21) increments for $PM_{10}$, $SO_2$, or $NO_2$was also determined.

*No Action.* No Action utilizes estimated air emissions data from operations at SRS in the year 2010 assuming continuation of site missions as described in section 3.3.5. These data reflect conservative estimates of criteria and toxic/hazardous emissions at SRS. The emission rates for the criteria and toxic/hazardous pollutants for No Action are presented in appendix table B.1.4–5. Table 4.6.3.3–1 presents the No Action concentrations. Pollutant concentrations are in compliance with all air quality regulations and guidelines. It is conservatively assumed that $PM_{10}$ concentrations are equal to TSP concentrations. The air quality at SRS in 2010 is expected to improve in comparison to the baseline air quality presented in section 4.6.2.3.

*Tritium Supply and Recycling Upgrade.* Alternatives for SRS consist of the four candidate technologies:

**TABLE 4.6.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Upgraded Recycling Including No Action at Savannah River Site* [Page 1 of 2]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | 2010 No Action ($\mu g/m^3$) | Tritium Supply Technologies and Upgraded Recycling: HWR ($\mu g/m^3$) | MHTGR ($\mu g/m^3$) | ALWR ($\mu g/m^3$) | APT ($\mu g/m^3$) | Tritium Recycling Phaseout ($\mu g/m^3$) | Tritium Upgrade ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|---|---|
| **Criteria Pollutant** | | | | | | | | | |
| Carbon monoxide (CO) | 8-hour | 10,000 | 14 | 14 | 15 | 14 | 14 | 14 | 0.4 |
| | 1-hour | 40,000 | 28 | 29 | 31 | 29 | 29 | 28 | 0.8 |
| Lead (Pb) | Calendar Quarter | 1.5 | [a] | [a] | [a] | [a] | [a] | [a] | [a] |
| Nitrogen dioxide ($NO_2$) | Annual | 100 | 10 | 10 | 10 | 10 | 10 | 10 | 0.1 |
| Ozone ($O_3$) | 1-hour | 235 | 235 | 235 | 235 | 235 | 235 | 235 | [a] |
| Particulate matter ($PM_{10}$)[b] | Annual | 50 | 28 | 28 | 28 | 28 | 28 | 28 | 0.02 |
| | 24-hour | 150 | 58 | 59 | 59 | 59 | 59 | 58 | 0.4 |
| Sulfur dioxide ($SO_2$) | Annual | 80 | 13 | 13 | 13 | 13 | 13 | 13 | 0.1 |
| | 24-hour | 365 | 182 | 184 | 184 | 184 | 184 | 182 | 1.7 |
| | 3-hour | 1,300 | 378 | 382 | 382 | 382 | 382 | 378 | 3.8 |
| **Mandated by South Carolina** | | | | | | | | | |
| Total suspended particulates[b] | Annual | 75 | 28 | 28 | 28 | 28 | 28 | 28 | <0.01 |
| **Hazardous and Other Toxic Compounds** | | | | | | | | | |
| Acetylene | 24-hour | [c] | [a] | 0.3 | 0.3 | 0.3 | 0.3 | [a] | [a] |
| Acrolein | 24-hour | 1.25 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | [a] |
| Acrylonitrile | 24-hour | 22.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | [a] |
| Ammonia | 24-hour | [c] | [a] | [a] | [a] | 0.6 | [a] | [a] | [a] |
| Antimony | 24-hour | 2.5 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | [a] |
| Benzene | 24-hour | 150 | 69.7 | 69.7 | 69.7 | 69.7 | 69.7 | 69.7 | [a] |
| Cadmium | 24-hour | 0.25 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | [a] |
| Cadmium oxide | 24-hour | 0.25 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | [a] |
| Chlorine | 24-hour | 75 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | [a] |
| 2,4-Dinitrotoluene | 24-hour | 1.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | [a] |
| Dioctyl phthalate | 24-hour | 50 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Ethyl alcohol | 24-hour | [c] | [a] | 0.1 | 0.1 | 0.1 | 0.1 | [a] | [a] |
| Ethyl benzene | 24-hour | 4,350 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | [a] |
| Ethylene glycol | 24-hour | 650 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | [a] |
| Formic acid | 24-hour | 225 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | [a] |

**TABLE 4.6.3.3–1.—*Estimated Cumulative Concentrations of Pollutants Resulting from Tritium Supply Technologies and Upgraded Recycling Including No Action at Savannah River Site* [Page 2 of 2]**

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline (μg/m³) | 2010 No Action (μg/m³) | Tritium Supply Technologies and Upgraded Recycling | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | HWR (μg/m³) | MHTGR (μg/m³) | ALWR (μg/m³) | APT (μg/m³) | Tritium Recycling Phaseout (μg/m³) | Tritium Upgrade (μg/m³) |
| **Hazardous and Other Toxic Compounds** (continued) | | | | | | | | | |
| Hexane | 24-hour | 200 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | a |
| Hydrogen chloride | 24-hour | 175 | 87.1 | 87.1 | 87.1 | 87.1 | 87.1 | 87.1 | a |
| Hydrogen sulfide | 24-hour | 140 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | 2.6 | a |
| Manganese | 24-hour | 25 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | a |
| Mercury | 24-hour | 0.25 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | a |
| Methane | 24-hour | c | a | 0.3 | 0.3 | 0.3 | 0.3 | a | a |
| Methyl alcohol | 24-hour | 1,310 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 |
| Methyl ethyl ketone | 24-hour | 14,750 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | a |
| Methyl isobutyl ketone | 24-hour | 2,050 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | 1.3 | a |
| Methyl tert-butyl ether | 24-hour | c | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | a |
| Methylene chloride | 24-hour | 8,750 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | a |
| Nickel | 24-hour | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | a |
| Nickel oxide | 24-hour | 5 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | a |
| Nitric acid | 24-hour | 125 | 1.5 | 2.1 | 1.5 | 9.3 | 1.5 | 1.5 | a |
| Sodium hydroxide | 24-hour | 20 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | a |
| Sulfuric acid | 24-hour | 10 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | a |
| Tetrachloroethylene | 24-hour | 3,350 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | a |
| Toluene | 24-hour | 2,000 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | a |
| 1,1,1-Trichloroethane | 24-hour | 9,550 | 0.7 | 0.8 | 0.7 | 3.3 | 0.7 | 0.7 | a |
| 1,1,2-Trichloroethane | 24-hour | 273 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | a |
| Trichloroethylene | 24-hour | 6,750 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 | a |
| Trichloromethane | 24-hour | 250 | 15.9 | 15.9 | 15.9 | 15.9 | 15.9 | 15.9 | a |
| Trichlorotrifluoroethane | 24-hour | c | a | 4.8 | a | a | a | a | a |
| Xylene | 24-hour | 4,350 | 11.6 | 11.6 | 11.6 | 11.6 | 11.6 | 11.6 | a |

[a] No sources indicated.

[b] It is conservatively assumed that all $PM_{10}$ concentrations are TSP concentrations.

[c] There is no standard.

Note: Concentrations for tritium supply and upgraded recycling and phaseout of tritium recycling include 2010 No Action concentrations. To determine the concentration of pollutants from each tritium supply technology, subtract the pollutant concentration for tritium upgrade from each of the tritium supply and upgraded recycling concentrations.

Note: DOE is committed to the phaseout of ozone-depleting substances and will discontinue use of these substances according to EPA phaseout schedules.

Source: DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR DHEC 1991a; SR DOE 1995a; SRS 1993a:3.

HWR, MHTGR, ALWR, and APT, combined with upgraded recycling facilities. Air pollutants would be emitted during construction of the tritium supply technologies. The principal sources of such emissions during construction include the following:

- Fugitive dust from land clearing, site preparation, excavation, wind erosion of exposed ground surfaces, and operation of a concrete batch plant.

- Exhaust from, and road dust raised by, construction equipment, vehicles delivering construction material, and vehicles carrying construction workers.

$PM_{10}$ concentrations are expected to be close to or exceed the 24-hour ambient standard during the peak construction period. Exceedances would be expected to occur during dry and windy conditions. Appropriate control measures would be followed, such as watering to reduce emissions. With the exception of $PM_{10}$, it is expected that concentrations of all other pollutants at the SRS boundary would remain within applicable Federal and state ambient air quality standards.

Air pollutant emission sources associated with the operation of each of the technologies include all or part of the following:

- Increased operation of existing boilers to generate additional steam for space heating.

- Operation of diesel generators and periodic testing of emergency diesel generators.

- Exhaust from, and road dust raised by, vehicles delivering supplies and bringing employees to work.

Appendix table B.1.4–5, presents emissions from each of the proposed tritium supply technologies. There are no gaseous releases associated with the APT, although emissions are associated with operation of the tritium supply facility and with upgraded tritium recycling facilities (SNL 1995a). Emissions from the Large ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Concentrations from operation of the tritium supply and upgraded recycling facilities at SRS are presented in table 4.6.3.3–1. Pollutant concentrations, combined with No Action concentrations, are in compliance with all applicable Federal and state standards.

Pollutant emissions resulting from the operation of tritium supply technologies alone (HWR, MHTGR, ALWR, and APT) consist of criteria pollutants from the operation of boilers and diesel generators and toxic/hazardous pollutant emissions from facility processes. Criteria pollutant emissions from the MHTGR are the highest among the other tritium supply technologies and would increase existing total site criteria pollutant emissions by less than 5 percent above No Action emissions. Concentrations of criteria and toxic/hazardous pollutants, added to No Action concentrations, are in compliance with Federal and state standards.

*Less Than Baseline Operations.* Air emissions from the HWR would be reduced slightly when operated at reduced capacity. However, the reduction would be negligible since most emissions are attributed to support equipment and facilities that are not related to the reactor operating level. The MHTGR or ALWR would have no change in air emission since it would continue to operate at the same level as the baseline requirement to maintain power levels for steam or electrical production. The Phased APT construction and operation emissions and impacts would be the same as the Full APT.

*Phaseout Tritium Recycling.* Phaseout of the tritium recycling facilities at SRS will reduce the criteria and toxic/hazardous pollutant emissions. The concentrations of pollutants resulting from this phaseout result in a net reduction of criteria and toxic/hazardous pollutant concentrations with respect to the No Action pollutant concentrations. The concentrations of criteria and toxic/hazardous air pollutants resulting from the phaseout of the tritium recycling facilities are in compliance with all applicable standards.

*Potential Mitigation Measures.* Potential mitigation measures during construction include: watering to reduce dust emissions; applying non-toxic soil stabilizers to all inactive construction areas, cover, water,

or apply non-toxic soil binders to exposed piles (i.e., gravel, sand, dirt); suspend all excavation and grading operation when wind speeds warrant; pave construction roads that have a traffic volume of more than 50 daily trips by construction equipment; use electricity from power poles rather than temporary gasoline and diesel power generators. Potential mitigation measures during operation include incorporating additional HEPA filters to reduce particulate emissions from processing facilities; substituting cleaning solvents which are less toxic for those which present health hazards or exceed the applicable standards; and switching from coal or fuel oil, to natural gas to reduce criteria pollutants.

**Acoustics.** The location of the tritium supply technologies relative to the site boundary and sensitive receptors was examined to determine the contribution to noise levels at these locations and the potential for onsite and offsite impacts.

*No Action.* Continuation of operation at SRS would not appreciably change traffic noise and onsite operational noise from current levels (section 4.6.2.3). Sources of nontraffic noise associated with operation are located at sufficient distances from offsite noise sensitive receptors that the contribution to offsite noise levels would continue to be small.

*Tritium Supply and Recycling Upgrade.* Noise sources during construction may include heavy construction equipment and increased traffic. Increased traffic would occur onsite and along offsite major transportation routes used to bring construction material and workers to the site.

Most nontraffic noise sources associated with operation of any of the tritium supply technologies and recycling upgrade would be located at sufficient distance from offsite areas that the contribution to offsite noise levels would continue to be small. Due to the size of SRS, noise emissions from construction and operation activities would not be expected to cause annoyance to the public.

Noise impacts associated with increased traffic on access routes, would be considered in tiered-NEPA documents. Some nontraffic noise sources associated with construction and operation of the tritium supply technologies and recycling upgrade may be located close enough to offsite noise receptors that they could experience some increase in noise levels.

*Less Than Baseline Operations.* Baseline noise impacts would not change due to reactors operating at reduced tritium capacity or the construction and operations of a Phased APT.

*Potential Mitigation Measures.* Potential measures to minimize noise impacts on workers include the use of standard silencing packages on construction equipment and providing workers in noisy environments with appropriate hearing protection devices meeting OSHA standards. As required, noise levels would be measured in worker areas, and a hearing protection program would be conducted.

#### 4.6.3.4 *Water Resources*

Environmental impacts associated with the construction and operation of each of the proposed tritium supply technologies at SRS would affect surface water and groundwater resources. The proposed site for the tritium supply facility would be outside the 100-year floodplain; however, information on the location of the 500-year floodplain at SRS is currently unavailable. Groundwater will be used for construction and operation of the tritium facilities. The water withdrawals from groundwater would not adversely impact regional groundwater levels. No wastewater would be discharged directly to groundwater; therefore, groundwater quality will not be affected. Any construction-related impacts would be mitigated by standard erosion control practices.

Surface water from the Savannah River would be used for cooling system makeup. The greatest possible demand would not exceed 3 percent of the river's minimum flow. During operation of the tritium supply and upgraded recycling facilities, treated wastewater would be discharged to nearby streams. Cooling system blowdown from the tritium supply facility would also be discharged directly to a nearby stream. All discharges would be monitored to comply with NPDES permit limits. During operation, stormwater runoff would be collected and treated, if necessary, before discharge to natural drainage channels.

Table 4.6.3.4–1 presents existing surface water and groundwater resources and the potential impact of

the proposed tritium supply technologies and operation of the existing upgraded recycling facilities. Resource requirements shown in this table represent the total requirements at the site, including No Action.

**Surface Water.**

*No Action.* Under No Action, no additional impacts to surface water resources are anticipated beyond the effects of existing and future activities, which are independent of and unaffected by the proposed action. A description of the activities that would continue at SRS is provided in section 3.3.6. Because of termination of the K-Reactor and the F- and H-Canyons operations, surface water withdrawals from the Savannah River would decrease to less than 2 percent of the river's minimum flow. As a result of reduction in discharges to site streams, water quality should improve and impaired streams should recover.

*Tritium Supply.* Due to the location of the proposed TSS, the most likely stream to receive discharge during construction and operation is Fourmile Branch. During construction of any tritium supply technologies, no surface water withdrawals would be made. Treated sanitary wastewater released to surface streams would not exceed approximately 2 percent of the minimum flow of Fourmile Branch. All discharges would be monitored to comply with NPDES permit limits and other discharge requirements. The primary impacts during construction would be soil erosion of disturbed land and siltation in surface drainage channels. To minimize soil erosion impacts, required NPDES stormwater management and erosion control measures would be employed. In most cases, impacts from runoff would be temporary and manageable.

In addition to wastewater effluent, the MHTGR and APT would require dewatering because of construction activities below the water table. The amount of dewatering discharges would depend on hydrologic and engineering conditions of the site. These discharges could either be directed to Fourmile Branch or Par Pond and are expected to exhibit low turbidity and not require settling basins. However, temporary sediment basins to remove soil particles could be built as part of standard soil erosion and sediment control plans for the site. Dewatering discharges to Fourmile Branch could cause stream bank erosion, increased turbidity, stream bed scouring, and potential flooding. More detailed analyses would be conducted during site-specific NEPA studies. Construction of an HWR or ALWR would require much less dewatering; therefore the impacts on Par Pond, Fourmile Branch or the Savannah River are expected to be minor.

Operation of the Large ALWR would require the most cooling water, 15,500 MGY, approximately 1.5 percent of the Savannah River's minimum flow, and would not be expected to affect downstream users. The water requirement for the other tritium supply technologies would require less than half the Large ALWR requirements. The greatest operational treated wastewater discharge would be 90 MGY from the Large ALWR. Fourmile Branch near the proposed TSS is an area of low instream flow and was determined by an SRS study to be acceptable for sanitary water discharges. The 90 MGY would comprise approximately 7 percent of the minimum flow of Fourmile Branch and would not be expected to adversely impact stream hydrology. All discharges would be required to comply with NPDES permit limits. Stormwater runoff from the main tritium supply plant area would be collected in detention ponds, monitored, and if clean, discharged to nearby streams. Stormwater from outside the main plant area, except those facilities that require on-site management controls by regulation such as sanitary wastewater treatment plants and landfill areas, would be discharged to nearby steams.

In addition to treated wastewater, cooling system blowdown discharges are anticipated. Cooling system blowdown activities discharge great quantities over a short period of time. An SRS study has examined six alternative routes for disposal of blowdown water that included Fourmile Branch, Par Pond, L Lake, Indian Grave Branch, and Savannah River. The evaluation of these alternatives was based on ecology, flow impacts, capability to assimilate discharge, impact on the biotic community, impact on existing permits, cost estimate, and feasibility. These evaluations identified Par Pond as the option with the least potential for environmental impact. The Large and Small ALWR would release 26 and 12 million gallons, respectively, as blowdown during one hour each day. All other tritium supply technologies would discharge less than half that of the Large ALWR. Blowdown from the Large ALWR would

**TABLE 4.6.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 1 of 2]**

| Affected Resource Indicator | No Action | Tritium Supply Technologies | | | | | | Tritium Recycling Upgrade[b] | Tritium Recycling Phaseout[b] |
|---|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | | |
| | | | | Large | Small | Full | Phased | | |
| **Construction** | | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | | |
| Water source | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground | Ground |
| Total groundwater requirement (MGY)[c] | 3,146 | 3,167 | 3,164 | 3,179 | 3,166 | 3,154 | 3,154 | 0.04 | NA |
| Percent increase in projected groundwater use (3,146 MGY) | 0 | 1 | 1 | 1 | 1 | 0.3 | 0.3 | NA | NA |
| ***Water Quality*** | | | | | | | | | |
| Wastewater discharge to surface waters (MGY) | NA | 16.5 | 13.6 | 27.5 | 15.5 | 0.3 | 0.3 | 0.03 | NA |
| Percent change in stream flow[d] | NA | 1 | 1 | 2 | 1 | <0.1 | <0.1 | NA | NA |
| NPDES permit required | NA | Yes | Yes | Yes | Yes | Yes | Yes | NA | NA |
| **Operation** | | | | | | | | | |
| ***Water Availability and Use*** | | | | | | | | | |
| Cooling system makeup (MGY) (from surface water) | Included in total | 5,800 | 4,000 | 15,500 | 7,100 | 2,635 | 1,684 | 30 | NA |
| Other facility operations (MGY) (from groundwater) | Included in total | 48 | 30 | 90 | 50 | 7 | 7 | 21 | -134.5 |
| Total surface water requirement (MGY)[e] | 19,840 | 25,640 | 23,840 | 35,340 | 26,940 | 22,475 | 21,524 | 30 | NA |
| Total groundwater requirement (MGY) | 3,146 | 3,194 | 3,176 | 3,236 | 3,196 | 3,153 | 3,153 | 21 | -134.5 |
| Percent change in flow from withdrawals[f] | 0 | 2 | 2 | 3 | 3 | 2 | 2 | NA | NA |
| Percent of projected groundwater use | 100 | 102 | 101 | 103 | 102 | 100.2 | 100.2 | NA | -4.3 |
| ***Water Quality*** | | | | | | | | | |
| Wastewater discharge to surface waters (MGY) | 52.3 | 100 | 82 | 142 | 102 | 59 | 59 | 31 | -0.4 |
| Percent change in stream flow[c] | 4 | 7 | 2 | 7 | 4 | 0.5 | 0.5 | NA | g |
| Blowdown discharge to surface waters (MGD) | Included in WW | 9.6 | 6.7 | 25.8 | 11.7 | 2.2 | 1.2 | NA | NA |
| Percent change in stream flow[h] | NA | 6,134 | 4,270 | 16,537 | 7,472 | 1,409 | 788 | NA | NA |
| NPDES permit required | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA | NA |

**TABLE 4.6.3.4–1.—*Potential Changes to Water Resources Resulting from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 2 of 2]**

| Affected Resource Indicator | No Action | Tritium Supply Technologies | | | | | | Tritium Recycling Upgrade[b] | Tritium Recycling Phaseout[b] |
|---|---|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR[a] | ALWR[a] | | APT | | | |
| | | | | Large | Small | Full | Phased | | |
| **Floodplain** | | | | | | | | | |
| Action in 100-year floodplain | NA | No | No | No | No | No | No | No | No |
| Critical actions in 500-year floodplain | NA | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain | Uncertain |
| Floodplain assessment required | NA | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year | Yes 500-year |

[a] Operational water requirements for MHTGR and ALWR include utilization of steam turbine generators.

[b] Resource requirements for tritium recycling upgrade and tritium recycling phaseout do not include No Action.

[c] Total water requirements for construction at SRS are calculated by adding baseline requirements (3,146 MGY) with that for each tritium supply technology HWR (21.3 MGY), MHTGR (17.8 MGY), ALWR (20 MGY for Small and 33.3 for Large), APT (8.3 MGY), and tritium recycling upgrade (0.1 MGY).

[d] Percent change in stream flow from wastewater discharge is from Fourmile Branch's minimum flow of 5.8 $ft^3/s$.

[e] Total water requirements for operation at SRS are calculated by adding baseline requirements for surface water (19,840 MGY) with that for each tritium supply technology HWR (5,800 MGY), MHTGR (4,000 MGY), ALWR (15,500 MGY for Large and 7,100 MGY for Small), APT (1,684 MGY for Phased and 2,635 MGY for Full), and tritium recycling upgrade (36.4 MGY); and for groundwater (3,146 MGY) with HWR (48 MGY), MHTGR (30 MGY), ALWR (90 MGY for Large and 50 MGY for Small), and APT (7.0 MGY for Phased and 7 MGY for Full), and tritium recycling upgrade (14.8 MGY).

[f] Percent change in stream flow from withdrawals is calculated from the Savannah River's minimum flow of 4,534 $ft^3/s$.

[g] Discharges would decrease by 0.3 percent to Upper Three Runs Creek and by 3.2 percent to Fourmile Branch.

[h] Blowdown is expected to occur once a day over a 1-hour period, rather than continuously over the course of the day. As such, the discharge rate would be much greater for a shorter period of time. Percent change in stream flow from blowdown discharge is calculated from Fourmile Branch's minimum flow of 5.8 $ft^3/s$.

Note: NA - not applicable; GW - groundwater; SW - surface water; WW - wastewater.

Note: Construction impacts are considered to be temporary, lasting only throughout the construction period. Impacts from operations would occur continuously.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

temporarily increase the average flow rate of Fourmile Branch by approximately 16,000 percent. These discharges would increase stream velocity, causing scouring of stream beds, erosion of stream channels, increased turbidity, resuspension and mobilization of contaminated sediments, and potential flooding of areas. In addition to impacts from the velocity of the blowdown, the temperature of the discharges could also affect receiving waters. Releases to Par Pond would reduce impacts from thermal discharges. Par Pond was designed as a recirculating cooling reservoir for several SRS reactors. Several precooling ponds (Ponds 2, 5, and C and a canal system) are tributaries to Par Pond. This system was designed to handle cooling water flows approximately 30 times greater than the proposed tritium supply technologies blowdown discharges. Currently, water is added to the system to maintain water levels. The precooling ponds are undergoing recovery from past thermal impacts of cooling water discharges. Discharge of blowdown to these ponds would not affect the flow, but some lake enrichment and biotic changes are possible. Blowdown discharges to Par Pond could reduce the amount of makeup water, but not eliminate, the need for makeup water from the Savannah River. The various blowdown disposal options would be evaluated in site-specific tiered NEPA documents. All discharges to surface waters are subject to and required to comply with NPDES permit requirements.

Blowdown would also contain concentrated chemicals and diffused tritium. Depending on the operation of the system, blowdown chemical and tritium concentrations would range between 2.5 and 5 times the river water concentrations. Previous studies of tritium concentrations in liquid discharges from reactors operating at higher production rates than anticipated for the proposed facilities showed that the concentration in the Savannah River after dilution did not exceed the water quality standard of 20,000 pCi/l (40 CFR 141). For the purpose of this analysis, it is anticipated that any release of tritium from the proposed facilities would not exceed the water quality standard for tritium and would comply with NPDES discharge requirements. For information on the radiological constituents present in cooling system blowdown and their human health impacts, refer to section 4.6.3.9.

Tritium supply facilities would be located at elevations approximately 50 feet higher than Fourmile Branch and at a distance of approximately 1 mile at its closest point. No tritium supply facilities would be located within a 100-year floodplain. However, there is no information on the location of the 500-year floodplain at SRS. Because the tritium supply facility may constitute a critical action, an assessment of the 500-year floodplain would be required before construction activities were initiated. This study would be done for site-specific assessments. However, where a potential exists for flooding impacts, design mitigation measures would be considered and addressed in site-specific tiered NEPA documents.

*Less Than Baseline Operations.* Baseline requirement surface water impacts would not be reduced appreciably due to changes in reactor (HWR, MHTGR, or ALWR) operating tritium capacities. A slight reduction in the volume and temperature of cooling water discharges would be expected for the HWR because of the lower thermal output of the reactor. The MHTGR or ALWR water requirements and discharges would not change from the baseline requirement in order to maintain power production; therefore, the potential impacts would remain the same.

Operation of the Phased APT would require 21,524 MGY (table 4.6.3.4–1), an 8-percent increase over projected No Action water use. This is approximately 1,000 MGY less than the amount required by the Full APT, and is 2 percent of the Savannah River's average flow. The 59 MGY of wastewater discharges from the Phased APT would not exceed 0.5 percent of Fourmile Branch's average flow and should not have any downstream effects. The Phased APT will discharge 1.2 million gallons of blowdown water during a one-hour period every day. This is approximately one-half the blowdown discharge of the Full APT, and is 788 percent of Fourmile Branch's average flow. This discharge is less than the blowdown of the other technologies and its impacts would be less than but similar to those of other technologies. All other requirements of the Phased APT are identical to those of the Full APT.

*Tritium Recycling Phaseout.* Phaseout of the tritium recycling facilities would result in a negligible decrease in withdrawals from the Savannah River.

Wastewater discharges would continue to Upper Three Runs Creek and Fourmile Branch but, due to the phaseout of tritium recycling, would decrease by 0.3 percent and 3.2 percent, respectively. Discharges to Fourmile Branch would still increase stream flow by almost 250 percent. Stream flows of this rate could impede the stream's ability to recover from previous impacts or continue to erode stream banks, cause flooding, increase turbidity, or scour stream beds.

*Tritium Recycling Upgrade.* The existing tritium recycling facilities would be upgraded and would continue to use both surface water and groundwater to meet operational water requirements. No increase in the discharge of effluents to onsite streams is anticipated.

*Potential Mitigation Measures.* Surface water impacts associated with construction could be mitigated by applying standard erosion control practices. Dewatering discharges, depending upon the amount, could be released to the Par Pond system to avoid potential impacts to Fourmile Branch. During operation, cooling system blowdown discharges could be released to energy dissipating structures, such as plunge or stilling basins. Lined conveyance channels with additional energy dissipation features could be designed to further reduce the velocity of flow prior to entering the natural stream channel. Discharges could also be directed through a series of detention ponds to reduce discharge velocities and allow the water to cool. Another option for the disposal of blowdown is to discharge to Pond 2, and from there the flow would go to Pond 5, to Pond C, to Par Pond, and to Lower Three Runs Creek, which is a tributary to the Savannah River. Such a discharge would not be expected to have any thermal impacts on Par Pond because the tritium supply cooling systems would be designed to meet applicable South Carolina requirements for thermal releases. During both construction and operation periods, the new Central Sanitary Treatment Facility at SRS could treat wastewater from the TSS. The treatment facility would have adequate capacity; the discharge is to Fourmile Branch.

**Groundwater.**

*No Action.* Under No Action, as discussed in section 3.3.6, the existing missions at SRS would continue with total groundwater usage of 3,146 MGY. Section 4.6.2.4 describes existing groundwater conditions at SRS. With the shutdown of the K- and L-Reactors and phaseout of the F- and H-Canyons operations, it is expected that groundwater use would decrease and groundwater quality would not be further degraded. Table 4.6.3.4–1 shows the amount of groundwater required for construction and operation of the proposed tritium supply technologies and their comparisons with SRS's projected groundwater usage.

**Groundwater Availability and Use.**

*Tritium Supply.* Groundwater required for construction of either an HWR (21.3 MGY), MHTGR (17.8 MGY), ALWR (33.3 MGY for Large and 20 MGY for Small) or an APT (8.3 MGY), would represent less than a 1-percent increase over the projected groundwater withdrawal. These amounts are not expected to cause any drawdown impacts.

Groundwater required for operation and the percent increase in projected water use are shown in table 4.6.3.4–1. Previous studies using numerical simulations of groundwater withdrawals up to 528 MGY from the Cretaceous aquifer indicate that although simulated drawdown was as much as 6.8 feet at the well head, drawdowns were smaller in overlying aquifers and did not extend beyond SRS boundaries in any aquifer. The studies concluded that withdrawing this amount of water or less would not adversely impact regional groundwater levels. Therefore, the productivity of this aquifer is sufficient to support construction and operation of the HWR, MHTGR, ALWR, and APT technologies. If needed, surface water instead of groundwater could be used for potable water and operation of support facilities.

*Less Than Baseline Operations.* Baseline requirement groundwater impacts would not be reduced appreciably due to changes in HWR, MHTGR, or ALWR operating tritium capacities. All groundwater requirements and potential impacts of the Phased APT are identical to those of the Full APT.

*Tritium Recycling Upgrade.* As discussed in section 3.4.3.2 the existing tritium recycling facilities at SRS would be upgraded. No new buildings would be constructed, rather construction would primarily be internal building renovations and modifications. Therefore, there should be no additional water use or impacts to water quality.

During operation, the upgraded tritium recycling facilities would require approximately 51 MGY of water. Of this 30 MGY would be used for cooling system makeup which is approximately 1.5 percent over the operational water requirements withdrawn from the Savannah River. Groundwater required for other facility operations (21 MGY) is 0.7 percent of the projected groundwater use. Therefore, no adverse impacts are anticipated to available water supplies.

*Tritium Recycling Phaseout.* In the event a new tritium supply and recycling facility is constructed at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. Phaseout of the tritium recycling facilities would decrease water withdrawals from the groundwater aquifers by 134.5 MGY. The reduced amount would not adversely impact groundwater levels or groundwater quality.

**Groundwater Quality.**

*Tritium Supply.* During construction of either a MHTGR or an APT, excavation would be required to extend to a depth of approximately 160 feet and 50 feet, respectively. This construction would not extend below the base of the water table aquifer. The water table drawdown resulting from dewatering the construction area could possibly induce horizontal flow of the contaminated groundwater (located less than one-half mile away), toward the excavated area from the SRS facilities surrounding the site. During excavation activities, groundwater would be monitored to avoid contaminated water from entering the construction area. Because the dewatering of the water table aquifer would create an upward gradient between aquifers, any potentially contaminated water in the excavated area would not likely migrate into the underlying aquifers.

During construction and operation of any of the tritium supply technologies, there are no plans for direct discharge to groundwater (also see surface water section 4.6.3.4). As a result, impacts to groundwater quality at SRS are not expected.

*Less Than Baseline Operations.* Impacts to groundwater quality from the HWR, MHTGR, or ALWR would be the same as the baseline tritium requirement. Potential groundwater quality impacts of a Phased APT would be the same as described above for the Full APT.

*Tritium Recycling Upgrade.* During construction and operation, there would be no direct wastewater discharge to groundwater. All wastewater effluent would be treated onsite and discharged to surface waters through NPDES-permitted outfalls (also see discussion on surface water). As a result, minimal impacts are anticipated to groundwater quality.

*Tritium Recycling Phaseout.* Phaseout of the tritium recycling facilities would reduce wastewater discharge into surface waters. Therefore, no impact to groundwater quality is anticipated.

*Potential Mitigation Measures.* Impacts from construction and dewatering activities may require mitigation. Mitigation measures which could be implemented during construction of either a MHTGR or an APT include continuous groundwater monitoring in the construction area during and after construction, and use of recharge wells to minimize the amount of groundwater from contaminated areas reaching the excavated area. During operation, the use of surface water instead of groundwater for potable water and operation of support facilities should be maximized.

### 4.6.3.5 *Geology and Soils*

Construction of tritium supply facilities at SRS would have no impact on geological resources. Hazards posed by geological conditions to construction and operation of a tritium supply facility at SRS are minor. Construction would disturb up to a few hundred surface acres of soil depending on the tritium technology. Control measures would be used to minimize soil erosion. Impacts would depend on the specific soil units in the disturbed area, the extent of land disturbing activity, and the amount of soil disturbed. Potential changes to geology and soils associated with the construction and operation of a tritium supply technology, tritium extraction facility, and upgrade of existing recycling facilities at SRS are discussed below.

*No Action.* Under No Action, DOE would continue existing and planned activities at SRS. The K-Reactor would remain in cold standby with no provision for restart, and the F- and H-Canyons

operations would eventually be shut down. These facilities would remain in place until turned over to environmental management for disposition. Any impacts to geology and soils from environmental management actions would be independent of and unaffected by the proposed action.

*Tritium Supply.* No potential project impacts to geologic conditions were identified. Design of the facilities would ensure compatibility with existing geologic conditions.

There are no known capable faults within the boundaries of SRS. There is little chance for ground rupture as a result of an earthquake. Ground shaking is more likely. Intensities as high as VII on the modified Mercalli scale are possible but infrequent and are not likely at SRS during the life of the proposed project. Ground shaking could affect the integrity of poorly designed or nonreinforced existing structures but would not affect newly designed facilities. Based on the seismic history of the area, a low seismic risk exists at SRS and should not preclude safe construction and operation of the tritium supply facilities. In addition, all facilities would be designed for earthquake-generated ground acceleration in accordance with DOE Order 5480.28 and accompanying safety guides.

Volcanic activity is not a factor anywhere in the region and is extremely unlikely to impact the project. It is also highly unlikely that landslides, sinkhole development, or other nontectonic movements would affect project activities. Slopes and underlying foundation materials are stable. The properties and conditions of soils underlying the proposed sites also have no limitation on construction. Potential health impacts from accidents associated with geological hazards are discussed in section 4.6.3.9.

Properties and conditions of soils underlying the proposed TSS have no limitations on construction. Soils would be impacted during construction and operation of the tritium facilities. The amount of acreage that would be potentially disturbed is shown in table 4.6.3.1–1.

The soil disturbance from construction of new facilities could be as much as 360 acres for a MHTGR. Disturbance would occur at building, parking, and construction laydown areas, destroying the soil profile, and leading to a possible temporary increase in erosion as a result of stormwater runoff and wind action. Soil losses would depend on frequency of storms; wind velocities; size and location of the facilities with respect to drainage and wind patterns; slopes, shape, and area of the tracts of ground disturbed; and, particularly during the construction period, the duration of time the soil is bare. Construction of both the MHTGR and the APT would also necessitate deep excavations to accommodate reactor modules and an accelerator tunnel respectively (see sections 3.4.2.2 and 3.4.2.4). A considerable volume of soil would be removed as a result of excavations. Most of the material removed would be sand or shale fragments derived from bedrock and could be stockpiled for use as fill. Some of this material could be used to cover the accelerator tunnel of the APT. Site-specific NEPA studies would evaluate in detail impacts to geology and soils at SRS resulting from deep excavations required for the MHTGR and the APT and would identify appropriate mitigation measures.

Net soil disturbance during operations would be less than for construction, because areas temporarily used for laydown would be restored. Although erosion from stormwater runoff and wind action could occur occasionally during operations, they are anticipated to be minimal.

Appropriate erosion and sediment control measures would be used to minimize soil loss. Wind erosion is likely to occur on an intermittent basis, depending on the wind velocities, the amount of soil exposed, and the effectiveness of control measures.

*Less Than Baseline Operations.* Under the less than baseline operation, geology and soil impacts would not change for the HWR, MHTGR, or ALWR technologies. Disturbed acreage for the Phased APT would be the same as the baseline tritium requirement case Full APT, therefore impacts would be the same.

*Tritium Recycling Upgrade.* The upgrade of tritium recycling facilities at SRS would not disturb any soil because no new construction would be required. The construction laydown area in the immediate vicinity of upgrade buildings would be temporarily disturbed. The upgrade would not affect existing geologic

conditions, and geologic conditions should not preclude safe construction and operation of the upgraded facilities.

*Tritium Recycling Phaseout.* In the event a new tritium supply is located at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. The existing tritium recycling facilities would remain in place following phaseout; therefore, no onsite impacts to geology or soils are anticipated.

*Potential Mitigation Measures.* Mitigation measures would be required to control erosion of soil, especially during construction. Potential mitigation measures include accepted standard practices for erosion, sediment, and dust control such as silt fences, sediment traps, runoff diversion dikes, drainageways, sedimentation ponds, establishment of ground cover and windbreaks, grading of slopes, and construction of berms or other controls appropriate to the site. Standard control for wind erosion, such as wetting the surface, could be done on a day-to-day basis. Exposing only small areas for limited periods of time, as necessary, would also reduce erosional effects. After the construction period, long-term control measures could include grading, revegetation, or landscaping.

#### 4.6.3.6 *Biotic Resources*

Construction and operation of a tritium supply technology and upgrade of existing recycling facilities at SRS would affect biotic resources. Impacts resulting from the construction of the HWR, MHTGR, ALWR, or Full APT to meet the baseline tritium requirement would occur only at the beginning of the project life cycle.

The less than baseline tritium requirement Phased APT could incur some additional construction-related impacts if expansion were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion would occur in the already developed main plant site. Impacts to terrestrial resources would result from the loss of habitat during construction and operation.

Impacts to wetlands would be avoided to the extent possible or mitigated in accordance with U.S. Army Corps of Engineers permit requirements. Water withdrawals would cause some minor increases in impingement and entrainment. During construction and operation, dewatering discharge and cooling system blowdown could impact wetlands and aquatic ecosystems; however, with appropriate mitigation, impacts to these resources could be reduced.

Federal-listed threatened or endangered species potentially affected by the proposed action are the short-nosed sturgeon and wood stork. Several special status species could be affected because of the destruction of plant species and less mobile animal species during construction. Where potential conflicts occur, mitigation measures would be developed in consultation with the USFWS. Consultation would be conducted during site-specific tiered NEPA document preparation. Table 4.6.3.6–1 summarizes the potential changes to biotic resources at SRS resulting from the proposed action. As noted in the table, no major differences in impacts to biotic resources exist between the four tritium supply technologies.

**Terrestrial Resources.**

*No Action.* Under No Action, missions described in section 3.3.5 would continue at SRS. This would result in no changes to current terrestrial conditions at the site described in section 4.6.2.6.

*Tritium Supply Facility.* Construction and operation of the HWR, MHTGR, ALWR, or APT would result in the disturbance of approximately 260 acres, 360 acres, 350 acres, or 173 acres, respectively, or less than 0.2 percent of SRS (table 4.6.3.6–1). These acreages include areas on which permanent tritium supply facilities would be constructed, as well as areas revegetated following construction. Vegetation within the proposed TSS would be lost during land-clearing activities. The majority of the proposed TSS consists of old fields and pine plantations that are common on SRS and throughout the region (SR DOE 1991b). Bottomland hardwoods and wetlands would be avoided to the extent possible.

Construction of a tritium supply facility would have some adverse effects on animal populations. Less mobile animals, such as amphibians, reptiles, and small mammals, within the project area would be destroyed during land-clearing activities.

**TABLE 4.6.3.6–1.—*Potential Impacts to Biotic Resources Resulting from Tritium Supply Technologies and Recycling During Construction and Operation at Savannah River Site***

| Affected Resource Indicator | No Action | Tritium Supply Technologies | | | | Tritium Recycling Upgrade |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | |
| Acres of habitat disturbed | 0 | 260 | 360 | 350 | 173 | 0 |
| Wetlands potentially impacted | None | Yes | Yes | Yes | Yes | None |
| Aquatic resources potentially impacted | None | Yes | Yes | Yes | Yes | None |
| Number of threatened and endangered species potentially affected[a] | 0/0 | 2/20 | 2/20 | 2/20 | 2/20 | 0/0 |

[a] The number of threatened and endangered species are represented by two data inputs (a/b) where: a is the number of Federal-listed threatened and endangered species, and b is the number of all other special status species (i.e., Federal candidate and/or state-listed species) that are potentially impacted.

Source: DOE 1992k; DOE 1992o:1; FDI 1993a; FDI 1993c.

Construction activities would cause larger mammals and birds to move to similar habitat nearby. The long term survival of these animals would depend on whether the area to which they moved was at or below its carrying capacity. Nests of migratory birds and young animals living within the proposed TSS could be lost during construction. Upon completion of construction, revegetated areas would be of minimal value to most types of wildlife because they would be maintained as landscaped areas.

During tritium supply operation, drift from cooling towers may cause salt deposition on surrounding land areas and vegetation. Previous studies for a tritium production reactor at SRS predicted that 13 acres would receive salt deposition at a rate of 15.2 pounds per acre per month. This is the deposition rate at which salt stress symptoms could become evident on sensitive plants (DOE 1992e). Although specific data are not available, all the potential tritium supply technologies would use less water than the previous design. Assuming similar parameters for the previous and current designs, impact from salt drift is expected to be less for the proposed tritium supply technologies. The potential impact to natural vegetation would be reduced because a portion of the salt drift would fall on developed areas in the vicinity of the cooling tower.

Activities associated with tritium supply facility operations, such as noise and human presence, could affect wildlife living immediately adjacent to the facility. These disturbances may cause some species to move from the area.

*Tritium Recycling Upgrade.* Upgrade of the tritium recycling facilities is not expected to impact terrestrial resources since all construction activities would take place within existing facilities.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have the same impacts described above for production at baseline tritium requirements.

Construction-related impacts of the less than baseline tritium requirement Phased APT would be similar to those described above. Some additional construction-related impacts could occur if expansions were needed to meet baseline tritium requirements. The potential impacts would be minor since the expansion activities would occur in the already developed main plant site.

*Potential Mitigation Measures.* The loss of habitat due to construction and operation of a tritium supply facility may be mitigated by revegetating with native species where possible. Disturbances to wildlife in areas adjacent to new facilities could be minimized by preventing workers from entering undisturbed areas. It may be necessary to survey the proposed construction site for the nests of migratory birds or eagles prior to construction and/or avoid clearing operations during the breeding season.

**Wetlands.**

*No Action.* Under No Action, the missions described in section 3.3.5 would continue at SRS. Because these facilities are already in place, no construction impacts would occur. Also, normal operations are not expected to adversely impact site wetlands. The continued shutdown of K-, L-, and P-Reactors would allow continued recovery of wetlands along the Steel Creek and Pen Branch stream corridors.

*Tritium Supply Facility.* Since the majority of the proposed TSS is upland, the facility could be located to avoid direct impacts to wetlands. Implementation of soil erosion and sediment control measures would control secondary impacts. Impacts to wetlands resulting from the construction of intake or outfall structures would be temporary. Any unavoidable displacement of wetlands would be made in accordance with the U.S Army Corps of Engineers permit requirements.

Construction wastewater discharge to Fourmile Branch would be minimal (section 4.6.3.4) and would not be expected to affect wetlands associated with the stream. However, without mitigation, dewatering discharge from an MHTGR or APT could result in adverse effects to Fourmile Branch and the Savannah River swamp. Stream bank scouring could cause a loss of vegetation bordering Fourmile Branch and could result in sediment build up in the Savannah River swamp. This could in turn cause swamp forest vegetation to be replaced by scrub/shrub or emergent vegetation. If dewatering discharge was directed to Par Pond, these impacts would be avoided. The controlled release of water from Par Pond would preclude impacts to wetlands associated with Lower Three Runs Creek.

Cooling system blowdown would be directed to either Fourmile Branch or Par Pond. Intermittent discharges of large volumes of water from cooling system blowdown to Fourmile Branch could adversely impact wetlands bordering the stream and the Savannah River swamp. Sediment build up in the Savannah River swamp resulting from streambed scouring could result in swamp forest vegetation being replaced by scrub/shrub or emergent vegetation. Also, erosion of stream banks could result in the loss of wetland vegetation. Thermal impacts to wetlands were not predicted for a previous larger tritium reactor planned for SRS (DOE 1992e); thus, such impacts are not expected for the proposed tritium supply technologies. All discharges would be required to comply with NPDES permit requirements.

As an alternative to discharging blowdown water from Fourmile Branch, water from cooling tower blowdown could be discharged to Par Pond via precooling ponds (i.e., Pond 2, Pond 5, and Pond C). Makeup water currently is pumped into Par Pond from the Savannah River to maintain its level and the proper rate of flow in Lower Three Runs Creek (DOE 1992e). If blowdown water from a tritium supply facility was sent to Par Pond, no impacts to wetlands would be anticipated since there would be no change in the level of Par Pond or the flow rate of Lower Three Runs Creek. Under this discharge alternative, sanitary wastewater would be discharged to Fourmile Branch. Due to the small volume of discharge, impacts to wetlands would not be expected. All discharges would be through NPDES-permitted outfalls. Impacts are not expected from salt deposition because the tritium supply facility could be sited away from wetlands and potential impacts would be limited to a relatively small area.

*Tritium Recycling Upgrade.* Upgrading the tritium recycling facilities would have no effect on wetlands at SRS because all construction activities would take place within existing facilities. Normal operation of the upgraded facilities would not impact site wetlands since liquid effluents would not be released to site streams.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have the same wetland impacts described above for the baseline tritium production requirement. However, operation of the HWR at reduced capacity would potentially reduce slightly the volume and temperature of cooling water discharges. The MHTGR, or ALWR related wetland impacts would not change from the baseline tritium production requirement consequences since the reactor would operate at the same level to maintain power levels for steam or electrical production. Construction and operation of a Phased APT would have similar wetlands impacts as described for the Full APT.

*Potential Mitigation Measures.* Construction impacts to wetlands could be avoided by siting facilities in areas away from wetland habitat, and implementing effective soil erosion and sediment control measures. The use of detention ponds would reduce the impact of discharges to wetlands associated with Fourmile Branch. Any unavoidable impacts would be mitigated according to DOE policy set forth in 10 CFR 1022 and in accordance with U.S. Army Corps of Engineers requirements. All effluent discharges to wetlands would be regulated through the provisions of an NPDES permit.

**Aquatic Resources.**

*No Action.* Under No Action, the missions described in section 3.3.5 would continue at SRS. This would result in no change to current aquatic conditions at the site. However, the continued shutdown of K-, L-, and P-Reactors would allow continued recovery of aquatic habitat along Steel Creek and Pen Branch corridor and a reduction in entrainment and impingement impacts.

*Tritium Supply Facility.* Stormwater runoff during construction of an HWR, MHTGR, ALWR, or APT at SRS could cause temporary water quality changes in Fourmile Branch, Pen Branch, and in Carolina bays. Increased turbidity could impact some fish spawning and feeding habitat. Fish populations would probably move to less disturbed areas of the stream and recolonize disturbed areas shortly after construction is complete and water quality improves. Construction of intake and discharge facilities would result in the temporary loss of habitat in the affected water bodies.

During construction, wastewater would be discharged to Fourmile Branch. These discharges would be minimal (section 4.6.3.4) and would not be expected to affect aquatic resources. Dewatering discharge from an MHTGR or APT could, without mitigation, result in increases in stream flow. Impacts to aquatic resources could result from streambed scouring, sedimentation and flooding, and could include changes in existing plant and animal communities. Directing dewatering discharge to Par Pond would preclude impacts to Fourmile Branch. Because Par Pond currently receives makeup water in order to maintain its present level, the addition of dewatering discharge would not impact the pond and, in fact, would lessen the makeup water requirements. The rate at which water is released from Par Pond to Lower Three Runs Creek would not change and therefore not affect the aquatic resources in the stream.

Operation of the HWR, MHTGR, ALWR, or APT would withdraw water from the Savannah River. The volume of water withdrawn represents a small percentage of the average flow of the river and would not affect its flow (section 4.6.3.4). However, an increase in entrainment and impingement of fish could occur. Based on previous studies for a large tritium production reactor at SRS (DOE 1992e) and monitoring of past SRS operations (WSRC 1989e), fish populations should not be adversely affected by entrainment losses from operation of a new tritium supply facility. Similarly, impingement losses should not adversely impact fish populations. Studies have shown that SRS operations have a low rate of impingement relative to power plants operating in the southeastern United States (DOE 1992e; WSRC 1989e). Impact to anadromous fish (e.g., striped bass and several species of shad) due to entrainment and impingement, would also be relatively low and would not adversely affect their populations. In compliance with the *Anadromous Fish Conservation Act*, populations of anadromous fish species on or near SRS would be sustained and their movement unobstructed by project construction and operation.

During operation, nonhazardous wastewater would be discharged to Fourmile Branch. Flow increases are not expected to adversely impact stream hydrology (section 4.6.3.4). Discharge of water from cooling system blowdown from an HWR, MHTGR, ALWR, or APT would be directed to either Fourmile Branch or Par Pond. Without mitigation, intermittent discharges of large volumes of water from blowdowns would greatly increase the flow rate of Fourmile Branch (section 4.6.3.4), causing flooding and stream bed scouring. These discharges could alter the aquatic ecosystem by displacing existing plant and animal communities. Previous studies for a large tritium production reactor at SRS indicated that water temperatures of discharges were expected to be within the thermal tolerance limits of native warmwater fish species. The temperature of water from blowdown discharges were also expected to be within normal water temperatures for each season and were not expected to alter the distribution or

abundance of aquatic organisms in receiving waters. However, the temperature of blowdown water discharged to Fourmile Branch was predicted to exceed the maximum temperature differential of 2.8 °C between effluent and receiving stream during the cooler months of the year. Such an exceedance would require a Section 316(a) demonstration of a balanced biotic community (DOE 1992e).

Discharge of blowdown to Par Pond would have no adverse flow impacts since the reservoir currently receives makeup water at rates greater than the predicted discharge rate for potential tritium supply technologies. In fact, projected discharges could reduce the need for makeup water for Par Pond. Thermal impacts to Par Pond would not be expected since discharged water would pass through a series of precooling ponds designed to meet the State of South Carolina requirements for thermal releases to Class B waters; however, the recovery of the precooling ponds from past thermal discharges would be affected. Regardless of the location of the outfall, all discharges would be required to meet NPDES requirements.

*Tritium Recycling Upgrade.* Upgrading the tritium recycling facility would have no impact on aquatic resources at SRS because all construction activities would take place within existing structures. Normal operation of the upgraded facility would not impact aquatic resources because liquid effluents would not be relegated to site streams.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would have similar impacts to aquatic resources at SRS as described above for the baseline tritium production requirement. However, operation of the HWR at reduced capacity would potentially reduce the volume and temperature of cooling water discharges and may result in less aquatic resource impacts. The MHTGR, or ALWR related aquatic resource impacts would not change from the baseline tritium production requirements consequences since the reactor would operate at the same level to maintain power levels for steam or electrical production. Construction and operation of a Phased APT would have similar aquatic resource impacts as described for the Full APT.

*Potential Mitigation Measures.* Impacts to aquatic resources could be mitigated by implementing a soil erosion and sediment control plan to reduce turbidity, and through the use of discharge detention ponds, avoid large increases in the rate of stream flow. Intake structures could be designed and operated to reduce intake flow rates, thereby reducing impingement and entrainment losses.

**Threatened and Endangered Species.**

*No Action.* Under No Action, the missions described in section 3.3.5 would continue, with no change in impacts to threatened and endangered species at SRS.

*Tritium Supply Facility.* Special status species that would potentially be impacted by the construction of a tritium supply facility include the awned meadow-beauty (Federal candidate, Category 2), green-fringed orchid, eastern tiger salamander (state, species of concern), Florida false loosestrife, beak-rush, star-nosed mole, and Cooper's hawk (state, undetermined). If present, individuals of each of these species could be destroyed, except the Cooper's hawk which could be temporarily displaced during construction. A pre-activity survey would be required prior to construction to determine the occurences of these and other special status species including the Federal-listed smooth purple coneflower (see table 4.6.2.6–1).

Impacts to special status species during facility operations would be minimal. The short-nosed sturgeon (Federal, endangered) has been observed in the Savannah River where cooling water would be withdrawn. Sturgeon eggs tend to sink and are strongly adhesive and gelatinous, which limits their downstream transport and dispersal through the water column. Thus, sturgeon eggs do not have a high entrainment risk. The preference of sturgeon larva for benthic habitat and the ability of juvenile and adult sturgeon to attain swimming speeds above the water intake velocity demonstrate the unlikelihood of impingement losses of this species (DOE 1992e). Cooling system blowdown discharged to Fourmile Branch could cause an increase in stream depth which could disrupt the foraging activities of the wood stork (Federal, endangered).

*Tritium Recycling Upgrade.* Upgrading the tritium recycling facilities would not impact threatened and endangered species since all construction activities would take place within existing structures. Normal

operation of the upgraded facilities would not adversely effect threatened and endangered species.

*Less Than Baseline Operations.* Operation of the HWR, MHTGR or ALWR at reduced tritium production capacity would be expected to result in similar impacts to threatened, endangered or sensitive species as described for the baseline tritium production requirement. Construction and operation of a Phased APT also would have similar impacts on the Federal-listed, Federal candidate, and state-listed species discussed above for the baseline tritium production requirement.

*Potential Mitigation Measures.* Disturbance of threatened, endangered, and special status species would be avoided where possible. Land clearing could be scheduled to avoid the nesting season of protected bird species. Where appropriate, a habitat restoration or propagation program could be attempted for plants when their disturbance is unavoidable. Potential impacts to the foraging activities of the wood stork could be mitigated by the use of detention ponds to control the cooling system blowdown discharge flow rate and avoid drastic stream depth increases. An alternative measure would be to direct cooling system blowdown water to Par Pond.

A biological assessment describing the impacts to Federal-listed species resulting from the proposed development of a tritium supply technology at SRS was previously submitted to the USFWS for evaluation. Further consultation with the USFWS would be required if SRS is selected as the location for the tritium supply facility and, if necessary, a detailed plan to mitigate impacts to Federal-listed threatened and endangered species at SRS would be developed. Currently, no critical habitat has been designated for threatened and endangered species at SRS.

#### 4.6.3.7 *Cultural and Paleontological Resources*

Cultural and paleontological resources may be affected directly through ground disturbance during construction, visual intrusion of the project to the historic setting or environmental context of historic sites, visual and audio intrusions to Native American resources, reduced access to traditional use areas, and unauthorized artifact collecting and vandalism. Intensive cultural resources inventories and site evaluations have not been conducted for the majority of the proposed TSS. Site-specific surveys and evaluations would be conducted in conjunction with tiered NEPA documents. Although the location and acreage for proposed tritium supply facilities will vary, the effects on cultural and paleontological resources are based primarily on the amount of ground disturbance; therefore, the facilities with the greatest surface area of ground disturbance will have the greatest effect on cultural and paleontological resources. Three NRHP-eligible historic sites and some important Native American resources may be affected by the proposed action. Effects to prehistoric and paleontological resources will be negligible.

**Prehistoric and Historic Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at SRS. Any impacts to prehistoric and historic resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply.* Land disturbance for the proposed tritium supply facilities (section 3.4) would range from 360 acres for the MHTGR to 173 acres for the smallest facility (APT) (section 4.6.3.1). Acreages for the HWR and ALWR would be 260 and 350, respectively. Three NRHP-eligible historic sites occur within the acreage that would be disturbed during construction. No NRHP-eligible prehistoric sites occur. Any project-related effects to NRHP-eligible resources will be addressed in tiered NEPA documentation. Because operation of facilities does not involve additional ground disturbance or increased activity, prehistoric or historic sites would not be affected.

*Less Than Baseline Operations.* No change in impacts to prehistoric and historic resources would be expected from operating the HWR at reduced capacity. Impacts for the MHTGR or ALWR would also not change from that described for the baseline requirement because the MHTGR or ALWR would not be a reduced size or operate at reduced capacity.

Construction and operation of the Phased APT would not change the expected impacts from the baseline tritium requirement since the disturbed area would be the same.

*Tritium Recycling Upgrade.* Because the upgrade of tritium recycling facilities does not involve ground disturbance, increased activity, or external building modifications, prehistoric and historic sites would not be affected.

*Tritium Recycling Phaseout.* In the event that a tritium supply technology and new recycling facility is constructed at a site other than SRS, the existing tritium recycling mission would be phased out at SRS. The existing tritium facilities would remain in place following phaseout; therefore, no onsite impacts to prehistoric or historic resources are expected.

*Potential Mitigation Measures.* If NRHP-eligible sites cannot be avoided through project design or siting, then the potential exists for an adverse effect. A Programmatic Memorandum of Agreement exists between the DOE, the South Carolina SHPO, and the Advisory Council on Historic Preservation for implementing the Archaeological Resources Management Plan. The plan describes intensive inventory and evaluation studies, data recovery plans, site treatments, and monitoring programs to be conducted if NRHP-eligible resources would be adversely affected. Mitigation measures for specific NRHP-eligible sites would be identified during preparation of tiered NEPA documents.

**Native American Resources.**

*No Action.* Under No Action, DOE would continue existing and planned missions at SRS. Any impacts to Native American resources from these missions would be independent of and unaffected by the proposed action.

*Tritium Supply.* Some Native American resources may occur within the acreages to be disturbed during construction of the tritium supply facilities. These Native American resources could include villages, traditional plant gathering areas, cemeteries, and burials. Operation of facilities may create audio or visual intrusions on Native American sacred sites in the vicinity or reduce access to traditional use areas. Specific concerns about the presence, type, and locations of Native American resources would be identified through consultation with the potentially affected Native American tribes, and any project-related effects would be addressed in tiered NEPA documents.

*Less Than Baseline Operations.* Impacts to Native American resources would not change due to less than baseline operation of the HWR, MHTGR, or ALWR. Construction and operation of a Phased APT would have similar impacts on Native American resources as those described for the baseline tritium requirement Full APT.

*Tritium Recycling Upgrade.* Because the upgrade of tritium recycling facilities does not involve ground disturbance or increased activity, Native American resources would not be affected.

*Tritium Recycling Phaseout.* Because phaseout of tritium recycling capabilities does not involve ground disturbance or increased activity, Native American resources would not be affected.

*Potential Mitigation Measures.* If Native American resources cannot be avoided through project design and siting, then acceptable mitigation measures to lessen the effect on these resources would be determined in consultation with affected Native Indian groups. Such mitigations may include, but not be limited to, appropriate relocation of human remains according to the *Native American Graves Protection and Repatriation Act*, planting vegetation screens to reduce visual and noise intrusions, increasing access to traditional use areas during operations, or transplanting or harvesting important Native American plant resources.

**Paleontological Resources.** Fossiliferous geological formations with surface exposures occur within areas designated for the proposed tritium supply facilities. All known paleontological materials consist of relatively common and widespread invertebrate fossils, and these assemblages have relatively low research potential. Consequently, while there may be effects on paleontological resources, impacts would be considered negligible for all the proposed tritium supply technologies at SRS.

*Less than Baseline Operations.* No change in impact to paleontological resources would be expected due to reduced operation of the HWR, MHTGR, or ALWR. Construction of a Phased APT would have the same impact on paleontological resources as the Full APT.

#### 4.6.3.8 *Socioeconomics*

Locating any of the tritium supply technologies and upgrading the existing recycling facilities at SRS would affect socioeconomics in the region. Section 3.2 provides descriptions for No Action, the tritium supply technologies with the tritium recycling facilities upgrade, and the phaseout of the tritium recycling mission. Each of these actions would create changes in some of the communities in both the ROI and the economic study area.

If tritium supply technology is located with the recycling facility at SRS, the in-migrating population could increase the demand for housing units. Additionally, there would be an associated increased burden on community infrastructure and subsequent effects on the public finances of local governments in the ROI. The increase of population could also burden transportation routes in the ROI.

Phaseout of the tritium recycling mission at SRS would also adversely affect the ROI through outmigration, housing vacancies, and unemployment. There would be a reduction in the demand for community services and infrastructure, but there would also be reductions in tax revenues.

The ALWR at SRS would create the greatest changes during construction, but the MHTGR, HWR, or ALWR would result in similar changes during operation. The APT would cause the fewest changes of the tritium supply technologies. None of these tritium supply technologies would increase population, the need for additional housing, or local government spending in the ROI beyond 3 percent over No Action during peak construction or operation. Although the greatest percent increases in employment, population and housing, and public finance during construction and operation occur in the peak years of 2005 and 2010, respectively, the annual average increases in the ROI over the construction period (2001 to 2005) are between 1 percent and 2 percent and less than 1 percent during operation (2010 to 2050). Between peak construction (2005) and full operation (2010), average annual growth varies from decreases of 1 percent to increases of 1 percent. None of the annual average increases associated with the tritium supply technologies and recycling upgrade constitutes a major difference from the No Action annual average increases.

The effects of locating any of the tritium supply technologies and upgrading existing recycling facilities at SRS are summarized in section 4.6.3. The following sections describe the effects that locating one of these technologies or phasing out the tritium recycling mission would have on the local region's economy and employment, population, housing, public finances, and local transportation.

**Employment and Local Economy.** Changes in employment and levels of economic activity in the 26-county economic study area from the proposed siting of tritium supply technologies and tritium recycling facilities upgrade or phaseout of the tritium recycling mission at SRS are described in this section. Although specialized personnel, materials, and services required for construction and operation would be imported from outside the area, a significant portion of these requirements would be available in this economic study area. Figures 4.6.3.8–1 through 4.6.3.8–3 present the potential changes in employment and local economy that would occur with all of the technologies and recycling facilities upgrade and tritium recycling phase out.

*No Action.* Under No Action, employment at SRS decreased to approximately 20,300 persons in 1994. This is a decrease of about 2,000 persons from the 1990 employment. SRS employment is projected to total almost 16,900 persons in 2010 and remain at this level through 2020. Historical and future employment projections at SRS are presented in appendix table D.2.1–1. The total SRS payroll was approximately $1.23 billion in 1994 and is projected to total $1.09 billion in 2010.

Total employment in the economic study area is projected to grow less than 1 percent annually between 2001 and 2005, reaching approximately 559,900 persons, and to decrease by less than 1 percent annually between 2010 and 2020, reaching 564,500 persons. The unemployment rate in the economic study area is expected to remain at 4.8 percent between 2001 and 2020. Per capita income is projected to increase from $18,300 to $21,000 during this 20-year period. No Action estimates are presented in appendix table D.3–73.

*Tritium Supply and Tritium Recycling Upgrade.* Construction activities would begin between the years 2001 and 2003 and would be completed

between the years 2007 and 2009. Upgrade of the tritium recycling facilities is expected to be completed between the years 2004 and 2007. Phasing in of employment for the operation of the tritium supply and the upgraded recycling facilities would begin in the year 2007 or 2009, peak at full employment by the year 2010, and continue at this level into the future.

Locating any of the tritium supply technologies and upgrading the tritium recycling facilities at SRS would create new jobs (direct) at the site. Additional indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new jobs. The total new jobs (direct and indirect) created would reduce unemployment and increase income in the economic region surrounding SRS during both the construction and operation periods of the proposed action.

Construction. Siting a tritium supply technology and upgrading the tritium recycling facilities at SRS would require a total of approximately 3,500 to 12,700 worker-years of activity over a 5- to 9-year construction period. This construction-related employment would indirectly create other jobs in the economic study area and total employment would grow at an annual average rate of 1 percent, until the peak year of 2005. Between peak construction (2005) and full operation (2010), average annual growth in employment would increase by much less than 1 percent for all of the tritium supply technologies and recycling facilities upgrade. Figure 4.6.3.8–1 gives the estimates of total project-related jobs (direct and indirect) that would be created during peak construction (year 2005) for each of the tritium supply technologies with the tritium recycling facilities upgrade.

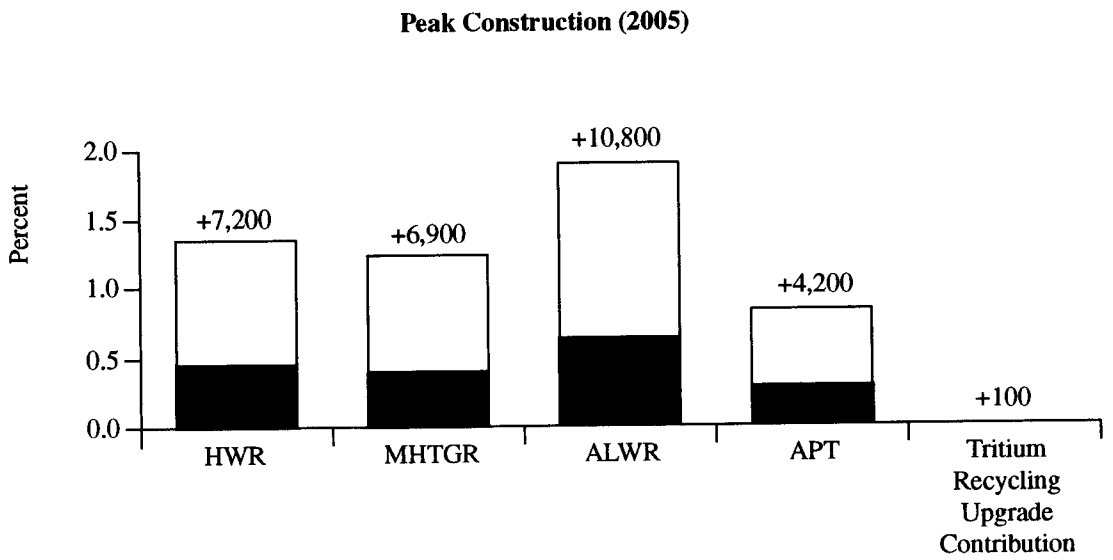
As employment opportunities would increase in the economic study area due to the proposed action, the unemployment rate would be reduced from the No Action estimate of 4.8 percent. Figure 4.6.3.8–2 presents a comparison of unemployment rates for the different tritium supply technologies and recycling facilities upgrade during peak construction in the year 2005. During the project's peak construction phase, the unemployment rate would range from a high of 4.2 percent to 3.9 percent, depending upon the tritium supply technology selected.

Income in the economic study area would also increase, particularly during peak construction as shown in figure 4.6.3.8–2. Per capita income is expected to increase slightly at an annual average of about 1 percent until the peak year of construction, 2005. Between 2005 and 2010, annual average growth in per capita income is also expected to increase by 1 percent for all of the tritium supply technologies. In comparison, under No Action, per capita income is expected to increase 1 percent annually.

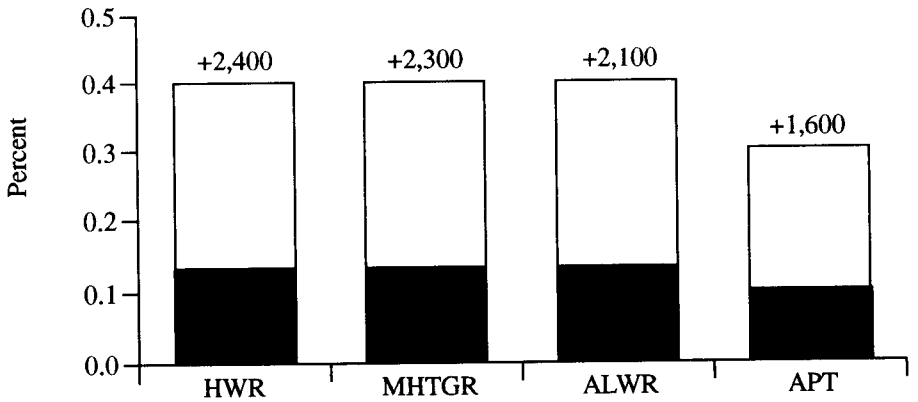
Operation. Siting a tritium supply technology would help offset the employment and income losses at SRS from the approximately 2,000 jobs lost between 1990 and 1994. The upgrade of tritium recycling would not create any additional facilities jobs at SRS. Employment for operation would begin phasing in as construction nears completion and the construction-related employment begins phasing out. It is expected that full operation employment would peak in the year 2010 and continue at this level into the future. Figure 4.6.3.8–1 gives the total project-related jobs projections (direct and indirect) for each of the tritium supply technologies with the upgrade of the tritium recycling facilities for the year 2010. Annual average growth in total employment would be flat between 2010 and 2020, similar to the No Action annual average growth rate.

Creation of additional job opportunities would also reduce the unemployment rate below that projected for No Action. Figure 4.6.3.8–2 presents the differences in unemployment rates during the first year of full operation employment (2010) for each of the tritium supply technologies with the upgraded tritium recycling facilities. From the years 2010 to 2020, unemployment would be reduced from the No Action projection of 4.8 percent to between 4.6 and 4.5 percent, depending upon the technology selected for the proposed action.

Income would also increase slightly in the economic study area as a result of the proposed action. Per capita income differences for tritium supply technologies with the upgraded tritium recycling facilities for the year 2010 are given in figure 4.6.3.8–2. Per capita income annual average increases would be about 1 percent between the years 2010 to 2020 for any of the tritium supply technologies located with the recycling facilities upgrade at SRS. The No




Note: Under No Action, total employment is 559,900 jobs.

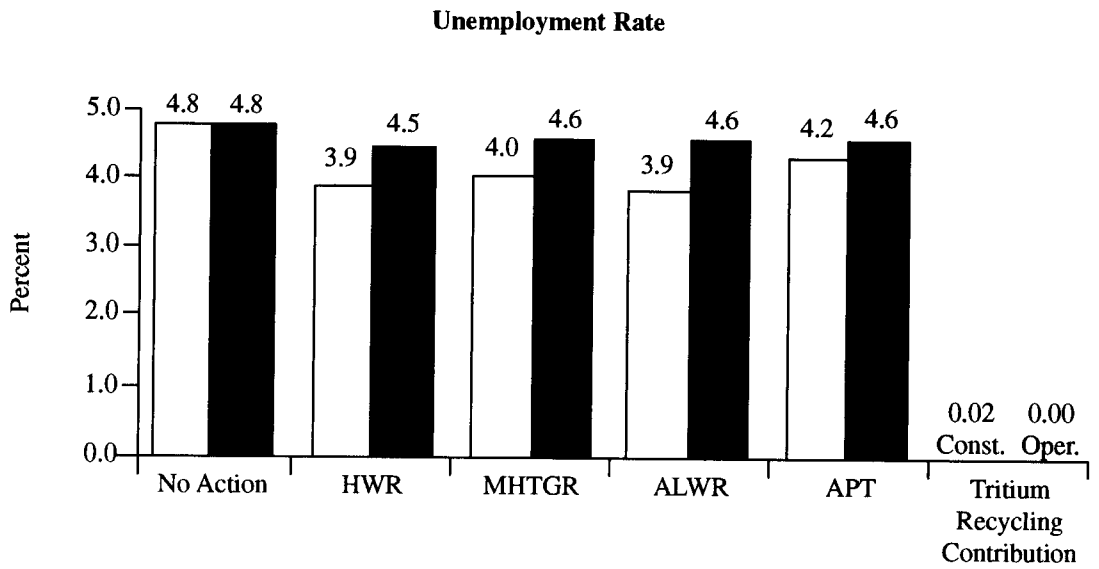



Indirect project-related jobs  Direct project-related jobs

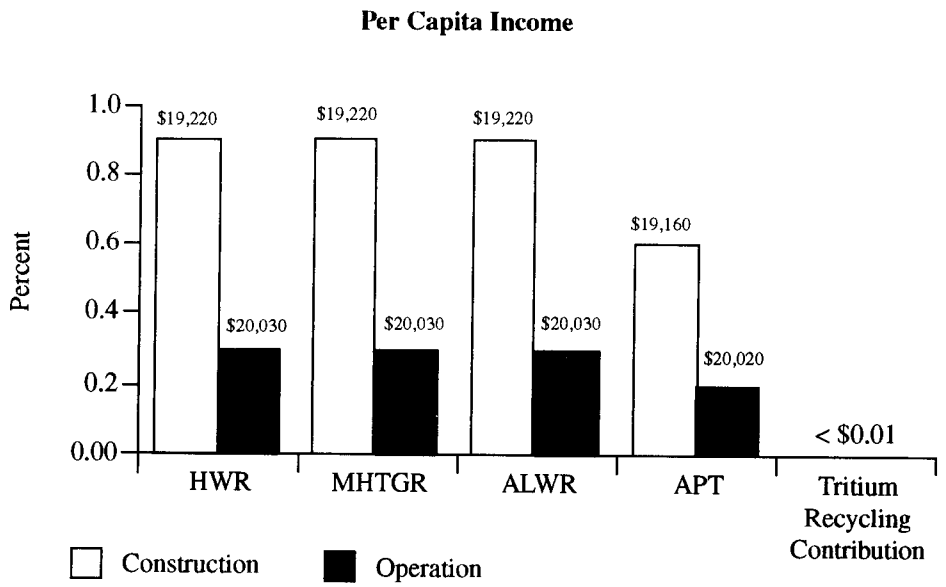
Note: Under No Action, total employment is 574,700 jobs. The percent increase in total employment during construction and operations was calculated by dividing the total project-related jobs by the total employment under No Action. The upgrade of tritium recycling facilities would not contribute to the total project-related employment.

Source: Appendix table D.3–74.

**FIGURE 4.6.3.8–1.—*Total Project-Related Employment (Direct and Indirect) and Percentage Increase over No Action from Tritium Supply Technologies with Recycling Upgrade for Savannah River Site Economic Study Area.***




Note: The upgrade of tritium recycling facilities would not affect the unemployment rate.
Source: Appendix table D.3–74.




Note: Under No Action, per capita income is projected to be $19,050 in 2005 and $19,980 in 2010.
Note: The upgrade of tritium recycling facilities would not contribute to per capita income increases during peak construction and full operation.
Source: Appendix table D.3–74.

**FIGURE 4.6.3.8–2.—*Unemployment Rate, Per Capita Income, and Percentage Increase over No Action from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Economic Study Area.***

Action projected annual average increase during the same period would also be approximately 1 percent.

*Tritium Recycling Phaseout.* Phasing out the tritium recycling mission at SRS would result in the loss of 800 total jobs (300 direct and 500 indirect). The unemployment rate in the economic study area would increase from a No Action estimate of 4.8 percent to 4.9 percent. Also as a result of phasing out the tritium recycling mission, per capita income in the economic study area would be reduced by approximately $20. Effects on employment and income from phasing out the tritium recycling mission in the year 2010 are provided in figure 4.6.3.8–3.

*Less Than Baseline Operations.* Tritium supply technologies that provide less than the baseline tritium operation capacities are described in section 3.1. These options may or may not be collocated with the tritium recycling facilities. The options include lowering the power in the HWR, using fewer target rods in the MHTGR or ALWR, and the phased approach for the APT.

Construction. The less than baseline operations case for the HWR, MHTGR, and ALWR would have the same construction workforce requirements as discussed in the tritium supply and recycling upgrade section. Therefore, employment and economic effects in the region would be the same.

The Phased APT would require the same total number of construction workers as the Full APT, but the construction period would span the years 1999 to 2008 instead of 2003 to 2007. Additionally, peak construction would occur in 2003 instead of 2005. The effects on the economic study area's employment, unemployment rate, and per capita income as a result of constructing the Phased APT with the tritium recycling upgrade are presented in appendix table D.3–74. Generally, average annual increases in employment and income are lower than the Full APT, but these increases are over a longer period of time. These increases are less than or equal to 1 percent, the same as the No Action estimates.

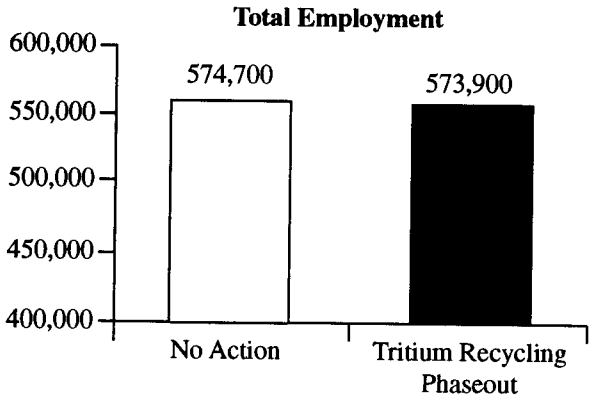
Operation. Operation workforce requirements for the less than baseline case for the HWR, MHTGR, ALWR, and the Phased APT would be the same as those described in the tritium supply and recycling upgrade section. Thus, regional employment and economic effects would be the same.

**Population and Housing.** Changes to ROI population and housing expected from the proposed location of a tritium supply technology and the upgraded tritium recycling facility at SRS are described in this section. If a tritium supply technology is located at SRS, additional population could be expected to in-migrate to the SRS region, and these people would be expected to reside in cities and counties within the ROI in the same relative proportion as the existing population. Increases to population could lead to a demand for additional housing units beyond existing vacant housing available during construction or operation phases of the proposed action. Alternatively, the phaseout of the tritium recycling mission could lead to population out-migration and an increase in housing vacancies in the ROI. Figures 4.6.3.8–4 through 4.6.3.8–6 present the changes in population and housing for the tritium supply technologies and tritium recycling facilities and tritium recycling phaseout.

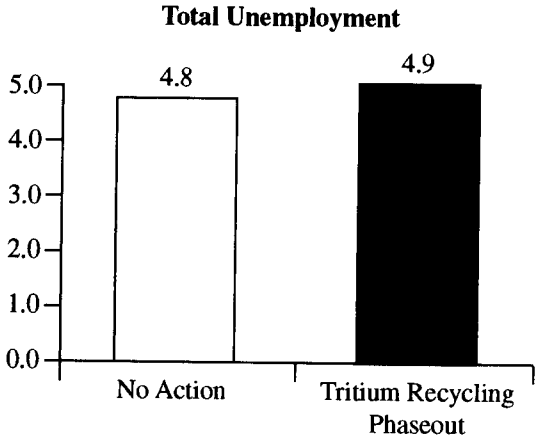
*No Action.* Population and housing annual average increases between 2001 and 2005 are projected to be less than 1 percent. Future annual average increases are also projected to be less than 1 percent between 2005 and 2010. Population in the ROI is estimated to reach 454,900 in 2010 and 473,000 in 2020. Total housing units in the ROI are estimated to reach 181,400 in 2010 and 188,400 in 2020. No Action estimates are presented in appendix tables D.3–75 and D.3–77.

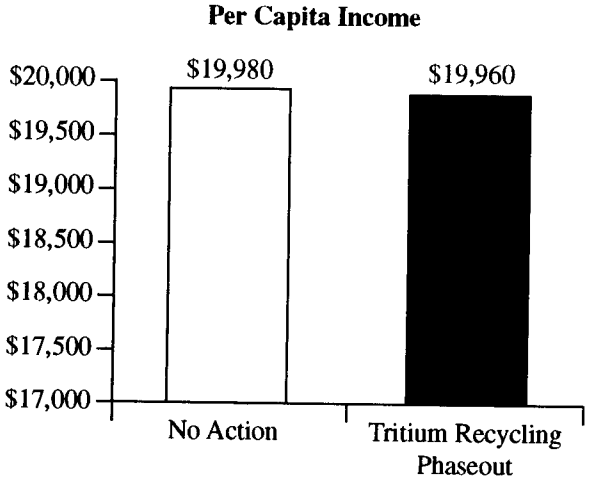
*Tritium Supply and Tritium Recycling Upgrade.* The location of a tritium supply technology and upgraded tritium recycling facility would increase population and housing demands in the ROI slightly (2 percent) over No Action projections during peak construction. The effects are expected to be fewer (much less than 1 percent) during the operation phase of the proposed action.

Construction. Construction activities would be phased over a 5- to 9-year period. Figure 4.6.3.8–4 illustrates that during peak construction (year 2005), the ALWR would create the largest population and housing demand increases over No Action, and the APT would have the least effects. The increase in population could require some additional housing




Note: Tritium recycling phaseout would result in a 0.14-percent decrease in total employment from No Action. Total direct and indirect employment lost would be approximately 800 jobs.




Note: Tritium recycling phaseout would result in a 0.09-percent decrease in per capita income from No Action.
Source: Appendix table D.3–74.

**FIGURE 4.6.3.8–3.—*Total Employment, Unemployment Rate, and Per Capita Income for No Action and Tritium Recycling Phaseout for Savannah River Site Economic Study Area, 2010.***

units beyond what are currently available in the existing housing mix. However, any requirements for additional housing units in the ROI would be at annual average increases of 1 percent in the first 3 years of construction of the ALWR. Between 2005 and 2010, population annual average growth in the ROI would be flat. The other tritium supply technologies would have annual average population and housing demand growth of less than 1 percent. Therefore, there would not be any major effects on any of the ROI communities.

Operation. Operation of tritium supply technology and upgraded tritium recycling facilities is expected to reach full employment by 2010. In-migrating population is expected to demand housing units similar to the existing housing mix in the ROI. Figure 4.6.3.8–5 shows that population increases and potential demand for additional housing units over No Action projections are almost negligible (much less than 1 percent) in this peak year. Given that the operations of the proposed action would be phased in over a 4-year period, it is expected that existing vacancies would absorb much of this new demand and that No Action requirements would be exceeded by very few units. The upgrade of tritium recycling facilities would not contribute to population growth.

*Tritium Recycling Phaseout.* Phasing out the tritium recycling mission at SRS would result in the loss of 800 jobs (300 direct and 500 indirect). Annual average growth in population and housing resulting from the phaseout would be the same as No Action. Effects on population and housing from this phaseout are presented in figure 4.6.3.8–6.

*Less Than Baseline Operations.* Population increases and housing demands would be the same or lower during construction and operation of tritium supply technologies operated at less than baseline tritium requirements than the alternatives discussed in the tritium supply and recycling upgrade section.

Construction. Population increases and housing demands would be the same as those given in figure 4.6.3.8–4 for the HWR, MHTGR, and ALWR. The Phased APT will increase population and housing demand during construction to the same level as the Full APT, but this will occur over a longer construction period with lower average annual increases. Also, the peak construction year would be 2003 instead of 2005. The effects of the Phased APT with the recycling upgrade on population and housing are given in appendix tables D.3–76 and D.3–78, respectively.

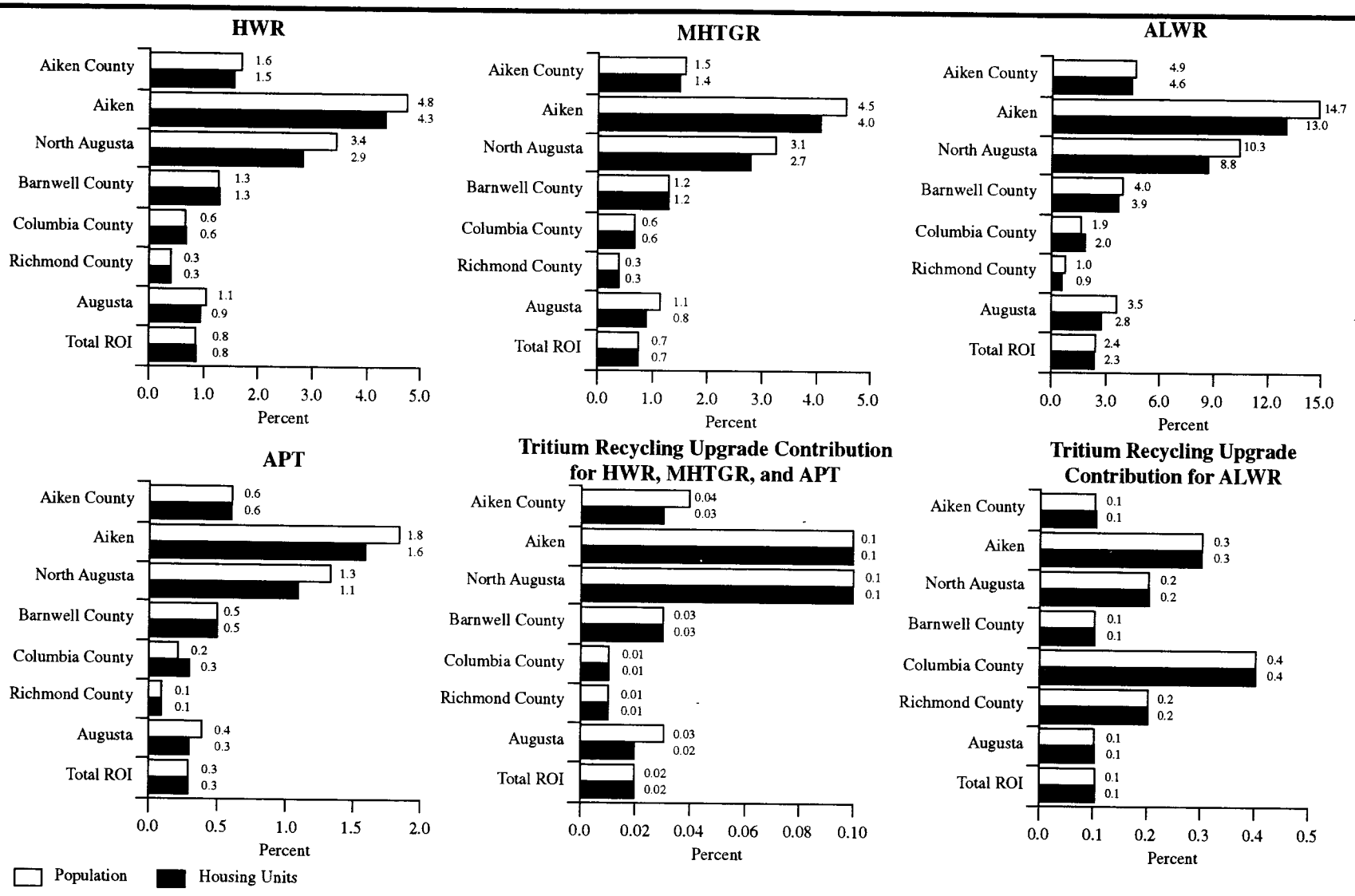
Operation. The effects on population and housing of operating the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirements would be the same as those given in figure 4.6.3.8–5.

**Public Finance.** Fiscal changes could occur in some ROI local jurisdictions from the proposed action. Factors influencing these changes include residence of project-related employees and their dependents, cost and duration of construction, and economic conditions in the ROI once the tritium supply and upgraded recycling facilities are operational.

Implementing the proposed action at SRS would increase population, resulting in more revenues for ROI local jurisdictions. Additional population would also increase public service expenditures.

Phaseout of the tritium recycling mission could result in a decrease in total revenues due to the out-migration of workers and their dependents. These revenue reductions may require the cities, counties, and school districts in the ROI to develop alternative revenue sources or reduce expenditures. Figures 4.6.3.8–7 through 4.6.3.8–12 present the potential fiscal changes that would occur with the different tritium supply technologies and the upgraded tritium recycling facilities and with the phaseout of the tritium recycling mission.

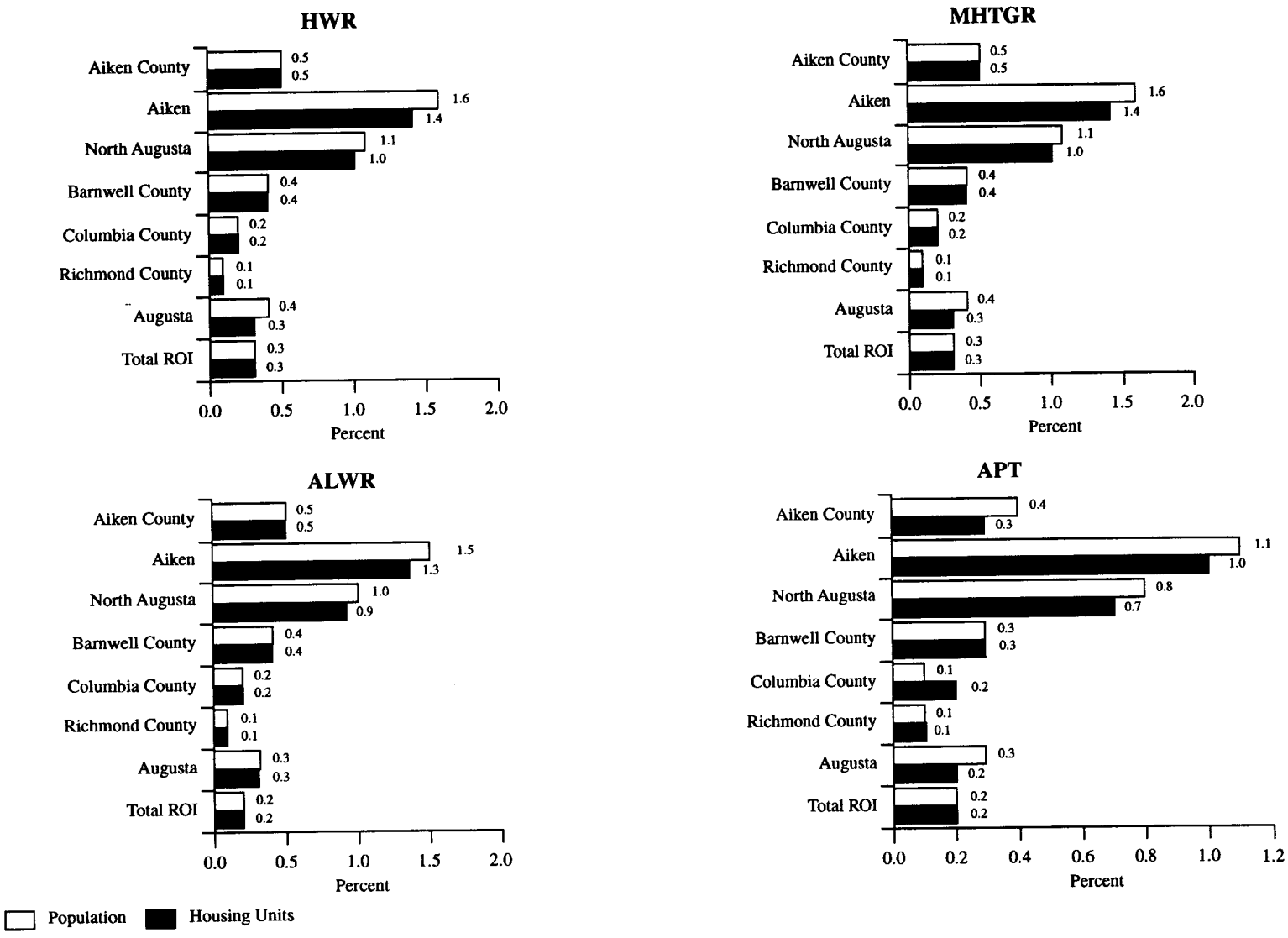
*No Action.* Appendix tables D.3–79 and D.3–80 present the 1992 public finances for ROI local jurisdictions. Appendix tables D.3–81 through D.3-84, present the impacts from the tritium supply technologies and upgraded recycling facilities compared to No Action construction and operation for the local counties, cities, and school districts. Between 2001 and 2005, ROI counties, cities, and school districts are projected to increase total revenues on an annual average of less than 1 percent. Total expenditures are also projected to increase on an annual average of less than 1 percent for ROI counties, cities, and school districts between 2001 and 2005. Additionally, between 2005 and 2010, total revenues and expenditures are expected to increase annually by less than 1 percent.




Note: Under No Action, population and housing in the ROI total 442,600 persons and 176,500 units, respectively. For county and city population and housing breakdowns, see appendix tables D.3–76 and D.3–78.

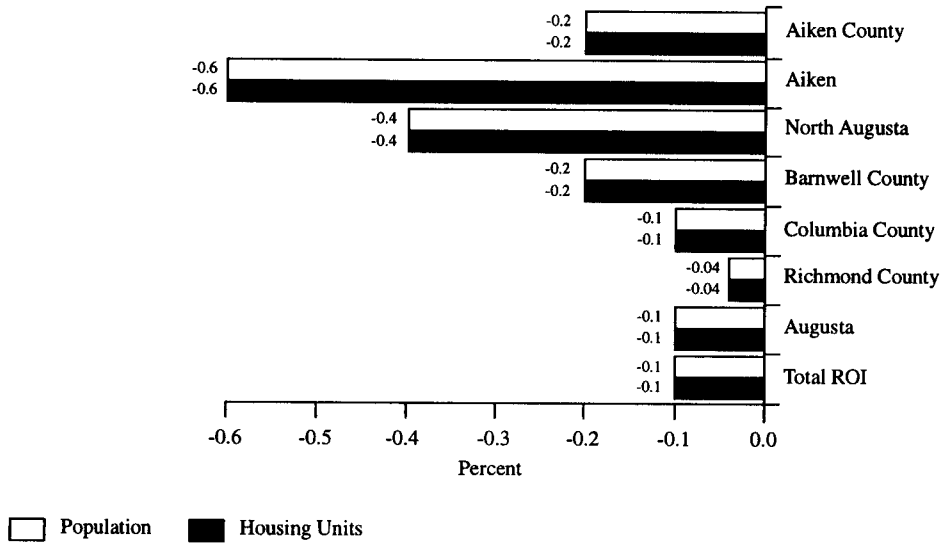
Source: Appendix tables D.3–76 and D.3–78.

**FIGURE 4.6.3.8–4.—*Total Population and Housing Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2005.***




Note: For county and city population and housing breakdowns, see appendix tables D.3–76 and D.3–78.
Source: Appendix tables D.3–76 and D.3–78.

**FIGURE 4.6.3.8–5.**—***Total Population and Housing Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2010.***




Note: Under No Action, population and housing in the ROI total 442,600 persons and 176,500 units, respectively. For county and city population and housing breakdowns, see appendix tables D.3–76 and D.3–78.
Source: Appendix tables D.3–76 and D.3–78.

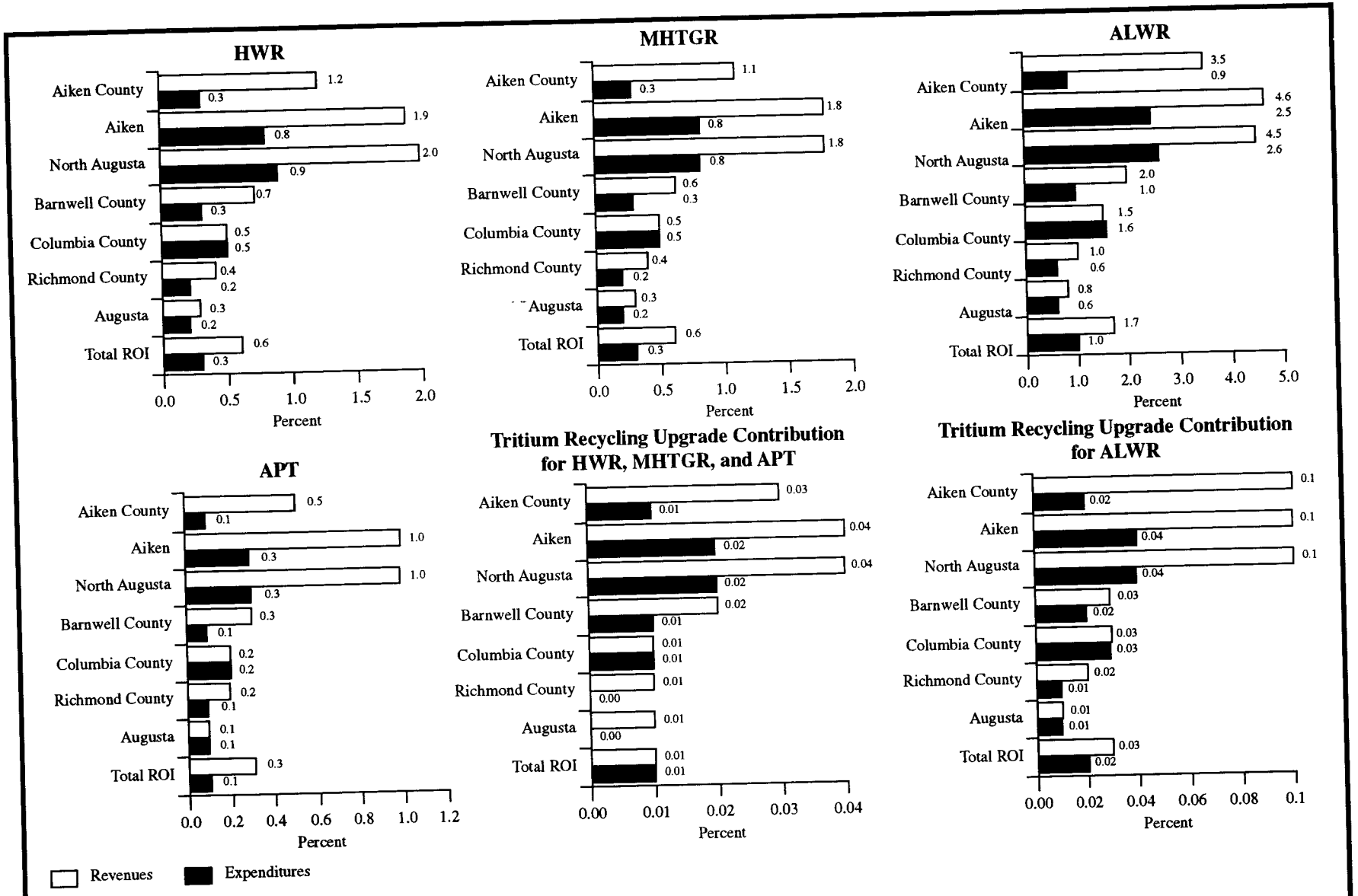
**FIGURE 4.6.3.8–6.—*Total Population and Housing Percentage Decrease Under No Action from Tritium Recycling Phaseout for Savannah River Site Region-of-Influence, 2010.***

Between 2010 and 2020, projected annual average increases in total revenues are less than 1 percent for counties, cities, and school districts in the ROI. Total expenditures are also projected to increase on an average by less than 1 percent or less for ROI jurisdictions between 2010 and 2020.

*Tritium Supply and Tritium Recycling Upgrade.* The proposed action at SRS would create some fiscal benefits to local jurisdictions within the ROI. Some local government finances would be affected during the construction and operation phases of the proposed action. Construction-related effects on revenues and expenditures could span a period of 5 to 9 years with the peak occurring in 2005. The effects of the operation phase would peak in 2010 and remain at this level throughout the life of the proposed action.

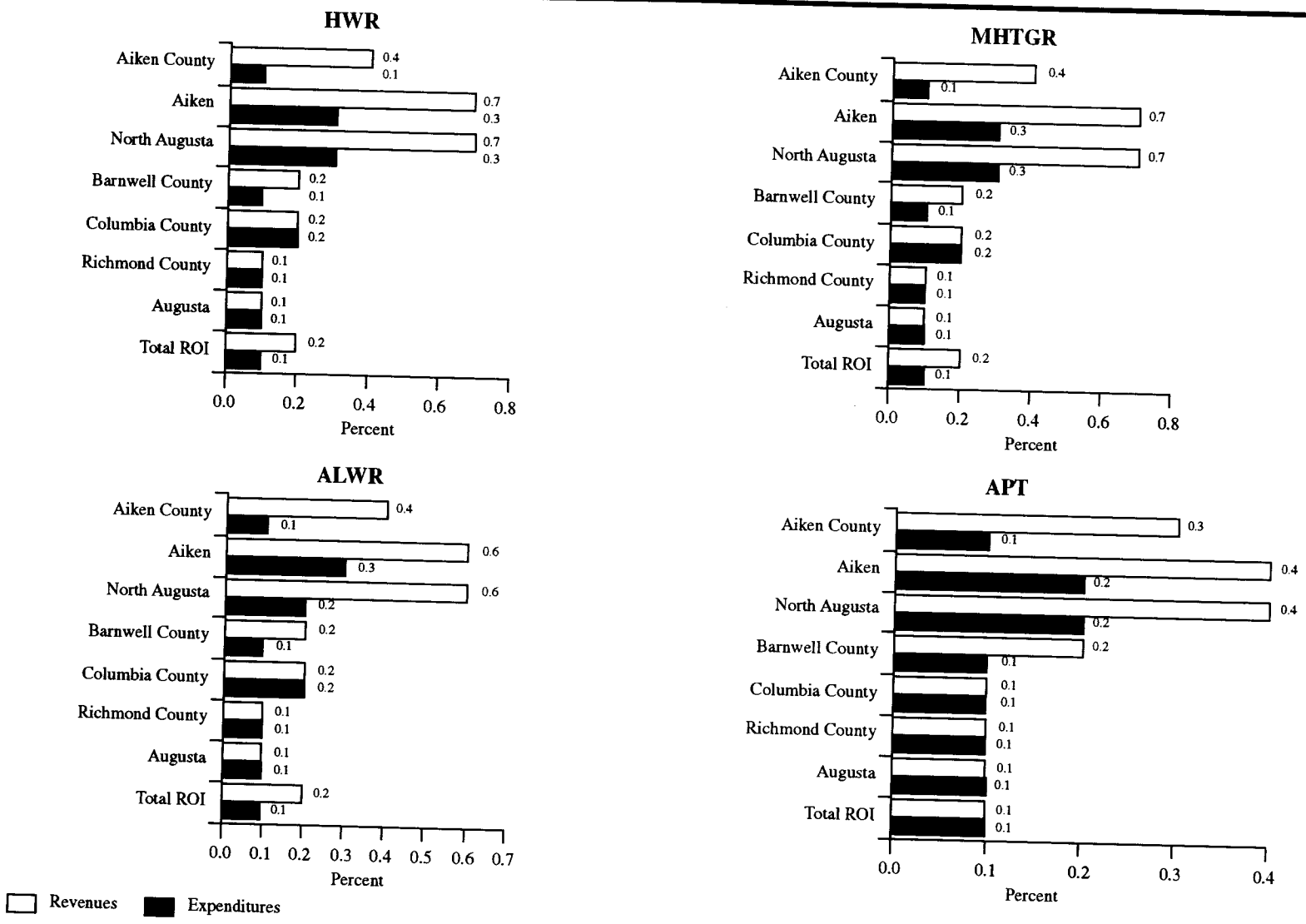
Construction. The public finances of counties, cities, and school districts within the ROI would be affected by the construction-related activities associated with the proposed action. Initially, there would be slight increases to some local government jurisdictions' revenues and expenditures, which would peak in the year 2005 and then decline as construction neared completion. Figures 4.6.3.8–7 and 4.6.3.8–10 present the revenue and expenditure changes of ROI local government jurisdictions and school districts over No Action during peak construction for the four tritium supply technologies with the upgraded tritium recycling facilities. Under the APT and the No Action estimates, local government revenues would increase at an annual average of 1 percent, and most local government expenditures would increase annually by 1 percent. Between 2005 and 2010 under these two scenarios, revenues and expenditures would grow less than 1 percent annually. With the ALWR, revenues and expenditures would increase between 4 percent to less than 1 percent in the first 3 years of construction. After the peak construction year, annual average growth in revenues and expenditures would be flat until 2010. With the HWR and MHTGR, revenues and expenditures would increase annually less than 1 percent between 2002 and 2005 and then grow annually much less than 1 percent until 2010.

Operation. The effects of phasing in operation together with the phasing out of construction on ROI local government finances would be fewer than the effects at peak or full operation (year 2010). The



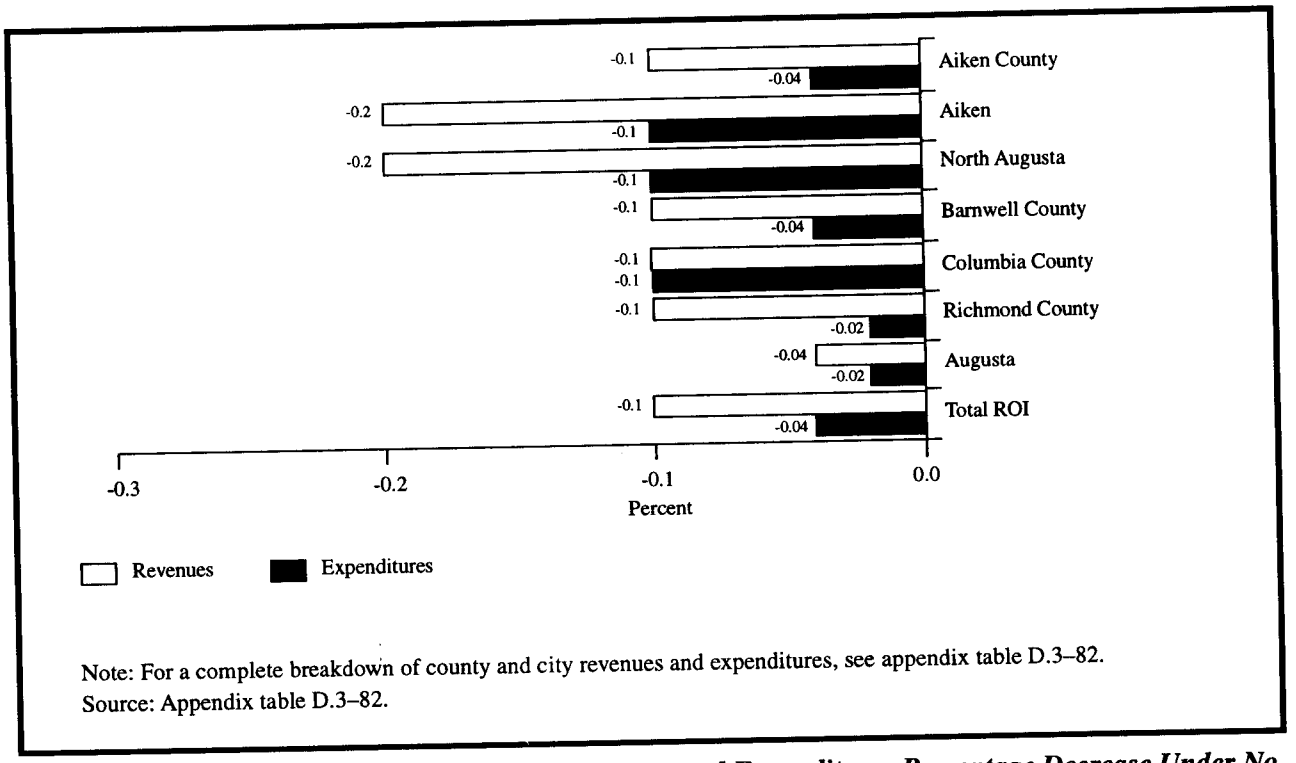

Note: For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–81.
Source: Appendix table D.3–81.

**FIGURE 4.6.3.8–7.—*County and City Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2005.***




Note: For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–82.
Source: Appendix table D.3–82.

**FIGURE 4.6.3.8–8.—*County and City Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2010.***




Note: For a complete breakdown of county and city revenues and expenditures, see appendix table D.3–82.
Source: Appendix table D.3–82.

**FIGURE 4.6.3.8–9.—*County and City Total Revenues and Expenditures Percentage Decrease Under No Action for the Tritium Recycling Phaseout for Savannah River Site Region-of-Influence, 2010.***

effects that the four tritium supply technologies and the upgraded tritium recycling facilities would have on county, city, and school district revenues and expenditures are presented in figures 4.6.3.8–8 and 4.6.3.8–11. The upgrade of recycling facilities would not contribute to revenue and expenditure increases. Between 2010 and 2020, revenues are expected to increase slightly at an average annual rate of less than 1 percent for all jurisdictions. Expenditures would also increase to the year 2020 at an annual average of less than 1 percent. No Action local government revenues would also increase at an average annual rate of less than 1 percent, and expenditures for most ROI local governments would grow annually at less than 1 percent.

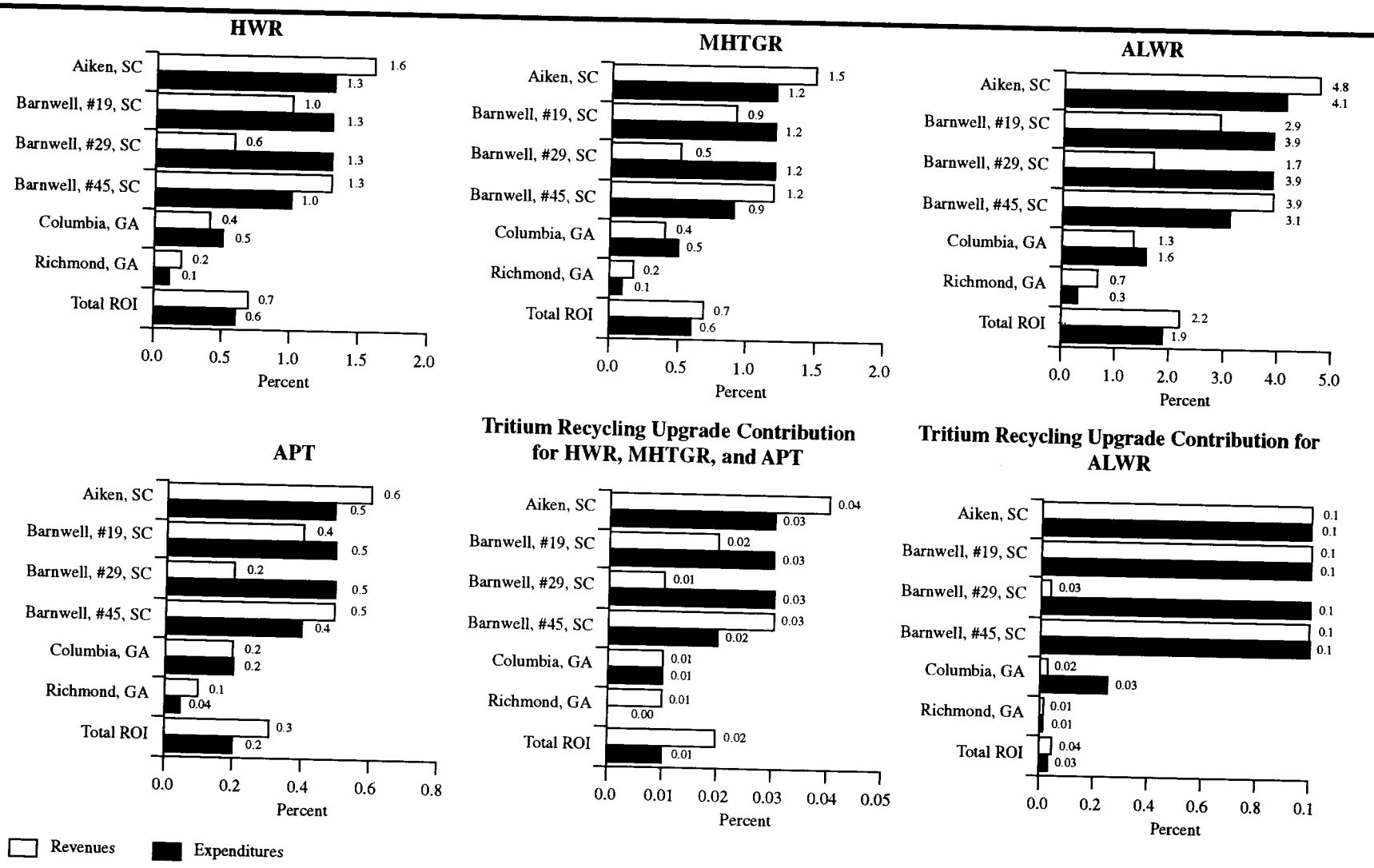
*Tritium Recycling Phaseout.* Phasing out the tritium recycling mission at SRS would result in a decrease in total revenues due to out-migration. The projected decreases in total revenues from baseline conditions are less than 1 percent for all ROI counties, cities, and school districts. Total expenditures would also decrease by less than 1 percent for all ROI jurisdictions. Effects on public finance from phasing out the tritium recycling mission are provided in figures 4.6.3.8–9 and 4.6.3.8–12.

*Less Than Baseline Operations.* The fiscal benefits that local jurisdictions would accrue from the location of a tritium supply technology alone or collocated with recycling would be the same or less if the tritium supply technology were operated at less than baseline tritium requirements.

Construction. Increases in local jurisdictions' revenues and expenditures would be the same as those given in figures 4.6.3.8–7 and 4.6.3.8–10 if the HWR, MHTGR and ALWR were built. If the Phased APT were constructed, the effects would peak in the year 2003 instead of 2005, and increases would be on an annual average lower. Appendix tables D.3–81 through D.3–84 give the revenue and expenditure changes as a result of constructing the Phased APT with the tritium recycling upgrade for all ROI jurisdictions.

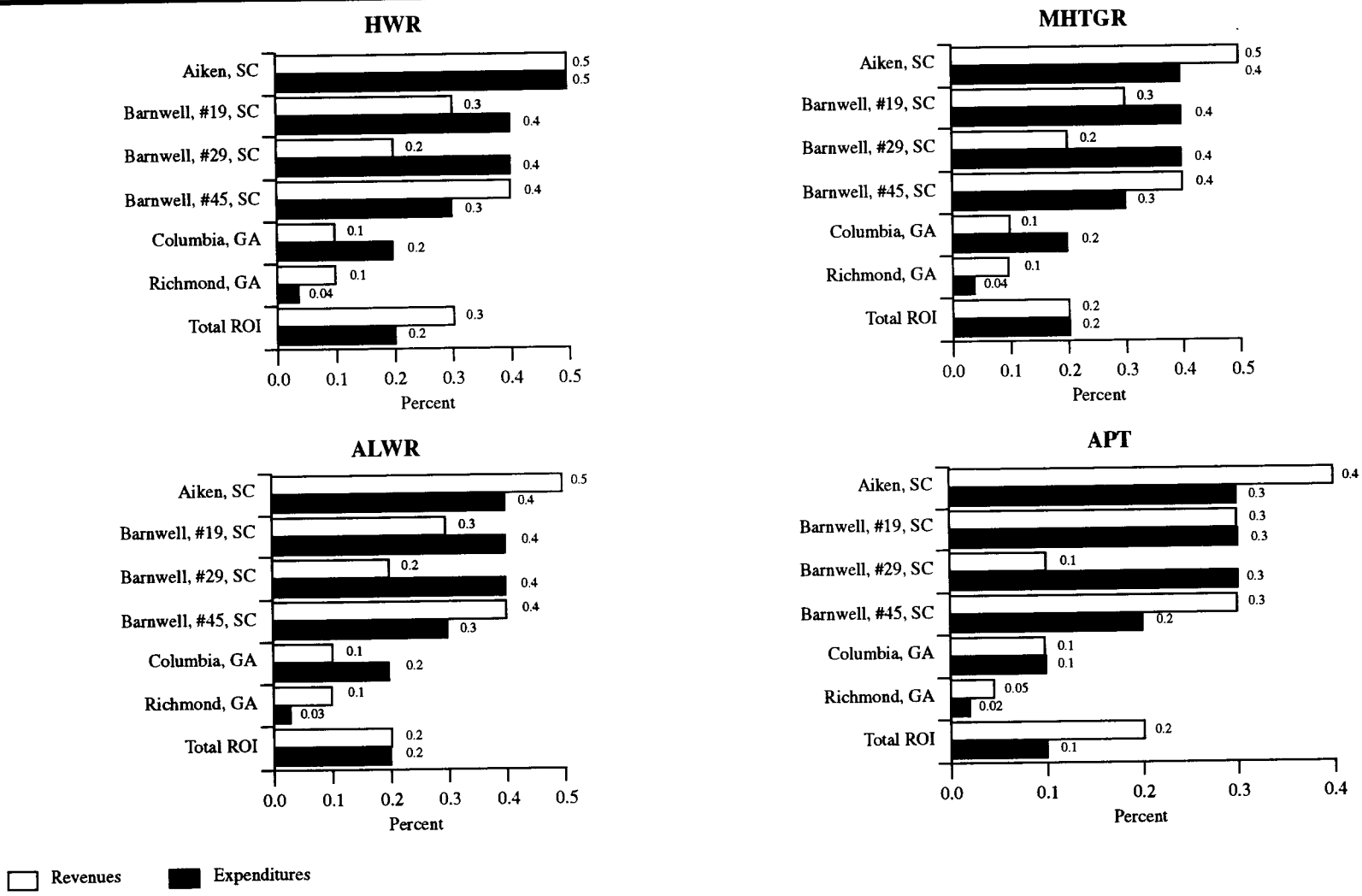
Operation. Operation of the HWR, MHTGR, ALWR and Phased APT at less than baseline tritium requirements would have the same effects on local jurisdictions' finances as those presented in figures 4.6.3.8–8 and 4.6.3.8–11.

**Potential Mitigation Measures.** Adding new missions to SRS would create new jobs and generally



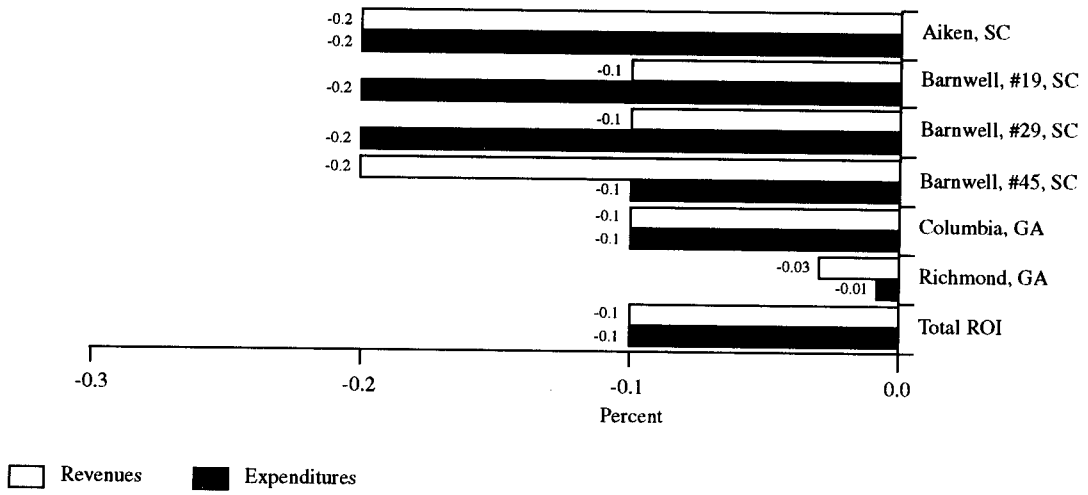

Note: For a complete breakdown of school district revenues and expenditures, see appendix table D.3–83.
Source: Appendix table D.3–83.

**FIGURE 4.6.3.8–10.—*School District Total Revenues and Expenditures Percentage Increase over No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2005.***




Note: For a complete breakdown of school district revenues and expenditures, see appendix table D.3–84.
Source: Appendix table D.3–84.

**FIGURE 4.6.3.8–11.—*School District Total Revenues and Expenditures Percentage Increase over No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2010.***




Note: For a complete breakdown of school district revenues and expenditures, see appendix table D.3–84.
Source: Appendix table D.3–84.

**FIGURE 4.6.3.8–12.—*School District Total Revenues and Expenditures Percentage Decrease Under No Action from the Tritium Recycling Phaseout for Savannah River Site Region-of-Influence, 2010.***

benefit the local economy through increased earnings in the ROI. Some mitigation measures may be required, such as Federal aid to local school districts where additional school age children would attend as a result of the proposed action. These new missions at SRS would increase population and the demand for additional housing units. Temporary housing units and mobile homes would help to alleviate the demand for new housing during the construction phase of the proposed action. Generally, construction would be phased over a period of 5 to 9 years with peak construction occurring in the year 2000. Phasing the start of operation employment and training between 2005 and 2010 would reduce the annual level of housing demand and smooth the peak and valley effect that would occur between peak construction and full operation.

Also, if the tritium recycling facilities were to be consolidated instead of the unconsolidated upgrade used in this analysis, the effects on population increase and housing demand would be lower because of reduced workforce requirements. If the tritium recycling mission is phased out at SRS, and this mission is relocated to another site, unavoidable adverse economic consequences and out-migration of population would occur. Housing vacancies would also occur as a result of out-migration. These adverse effects could be reduced if the tritium recycling mission is phased out over time rather than in the single year 2010.

Although the effects of the tritium recycling mission phaseout to the region would be small, DOE is concerned about these workers and has developed proposals for mitigating employment effects. DOE is implementing a comprehensive economic adjustment program for all DOE facilities that would accomplish Congressional objectives established in Section 3161 of the *National Defense Authorization Act* of 1993.

DOE's economic adjustment initiatives aimed at mitigating job reductions include:

- Announce workforce changes early in order to spread required layoffs rather than all in one action.

- Work with the local community to help define and obtain funding for economic development initiatives.

- Coordinate with Federal and state agencies to provide retraining assistance. Eligible defense programs workers could enter retraining programs for new jobs in Environmental Restoration and Waste Management.

- Continue health benefits.

- Where appropriate, DOE would offer cash incentives to encourage early retirements or voluntary separations.

- Establish employee and outplacement assistance programs Complex-wide. Employees subject to layoffs at one site would receive preference for hiring at other sites.

Some of the tritium recycling mission workers could be redeployed to meet other SRS mission requirements or new missions such as decommissioning and decontamination, or be transferred to another site where the tritium recycling mission would be located.

**Local Transportation.** The following is a description of the effects on local transportation resulting from locating new missions at SRS. Construction and operation of a tritium supply technology and the upgraded tritium recycling facilities are expected to increase traffic volume and flow on site access routes.

*No Action.* Under No Action, the worker population at SRS would not increase. Therefore, any increases in traffic would not be the result of DOE-related activities at SRS. Access to the nearest interstate highway is 30 miles via 2-lane roads that pass through congested and populated areas. Other nearby interstate highways are 50 miles via predominantly 2-lane roads that pass through rural areas and small towns. The ROI would rarely be affected by winter weather conditions that would restrict access to the site. Traffic conditions on site access roads would remain as described in section 4.6.2.8.

*Tritium Supply and Tritium Recycling Upgrade.* Locating any of the tritium supply technologies with the upgraded tritium recycling facilities at SRS would result in increases, depending on the technology, of worker population at the site. Traffic conditions on site access roads leading to and from SRS would worsen due to increased traffic volume and flow rates. The primary access route to SRS is State Route 125. This route would carry the greatest increase in traffic from site development. Currently this route and secondary branches leading to the various internal areas of SRS are congested during peak travel time. Locating the MHTGR or ALWR at SRS would have the greatest effect of the tritium supply technologies on traffic volume and flow (Huber 1990).

*Tritium Recycling Phaseout.* Phaseout of the tritium recycling mission would decrease worker population enough to change traffic conditions on site access roads leading to and from SRS, but this decrease would help reduce traffic volume and flow and improve traffic conditions only slightly.

*Less Than Baseline Operations.* The effects on traffic volume and flow would be the same whether or not the HWR, MHTGR or ALWR were operated at baseline or less than baseline tritium requirements. Construction of the Phased APT would increase traffic volume and flow during the construction phase but less than that for the Full APT.

*Potential Mitigation Measures.* Mitigation of traffic conditions may be necessary due to the proposed action at SRS. Mitigation could include the widening and extension of State Route 125, the primary access route to SRS, as well as possible realignment of roadways and construction of interchanges at roadway intersections overburdened by increased vehicle traffic and congestion. In addition, internal access routes connecting State Route 125 with the project area could be upgraded to carry the increased load.

#### 4.6.3.9 *Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents*

This section describes the impacts of radiological and hazardous chemical releases and their associated impacts resulting from either normal operation or

accidents at facilities involved with the tritium supply technologies and recycling facilities at SRS. The section first describes the impacts from normal operation followed by a description of impacts from facility accidents.

During normal operation at SRS, all tritium supply technologies would result in impacts that are within regulatory limits. The risk of adverse health effects to the public and to workers would be small.

For facility accident impacts, the results indicate that for all tritium supply technology alternatives, the risk of fatal cancers (taking into account both the portability of the accident and its consequences) from an accidental release of radioactive or hazardous chemical substances at SRS is low when compared to fatal cancers from all causes, even for a severe accident.

The impact methodology is described in section 4.1.9. Summaries of the radiological and chemical impacts associated with normal operation are presented in tables 4.6.3.9–1 and 4.6.3.9–2, respectively. Summaries of impacts associated with postulated accidents are given in tables 4.6.3.9–3, 4.6.3.9–4, and 4.6.3.9–5. Detailed results are presented in appendix E for normal operation and appendix F for accidents.

**Normal Operation.**

*No Action.* The current missions at SRS are described in section 3.3.5. The site has identified those facilities that will continue to operate and others, if any, which will become operational by 2010. Based on projected operations, the radiological and chemical releases for 2010 and beyond were developed and used in the impact assessments.

Radiological Impacts. As shown in table 4.6.3.9–1, No Action would result in a calculated annual dose of 2.9 mrem to the maximally exposed member of the public, which projects to an estimated fatal cancer risk of $5.7 \times 10^{-5}$ from 40 years of total site operation. This annual dose includes a dose from liquid releases of 0.077 mrem and a dose from atmospheric releases of 2.8 mrem. Both the liquid and atmospheric doses are within radiological limits, and when combined are 0.91 percent of the natural background radiation dose received by the average person near SRS.

The population dose from total site operation in the year 2030 was calculated to be 250 person-rem which projects to an estimated 4.9 fatal cancers from 40 years of total site operation. The population dose includes 0.45 person-rem from liquid releases and 250 person-rem from atmospheric releases, and would be approximately 0.11 percent of the annual dose received by the surrounding population from natural background radiation.

The annual average dose to a site worker resulting from No Action would be 32 mrem, which projects to an estimated total cancer risk of $5.2 \times 10^{-4}$ from 40 years of site operation. The annual dose to the total site workforce would be 480 person-rem, which projects to an estimated 7.7 fatal cancers from 40 years of total site operation.

Hazardous Chemical Impacts. As shown in table 4.6.3.9–2, No Action would result in a calculated HI of 0.70 and a cancer risk of $3.2 \times 10^{-5}$ to the maximally exposed member of the public. The calculated worker HI would be 1.8 with a cancer risk of $5.9 \times 10^{-3}$. The HI value is within the acceptable regulatory health limits for the maximally exposed member of the public, but exceeds the EPA action level of 1.0 for the onsite worker, based on EPA's regulations for public exposure limits and OSHA's regulations for worker exposure limits. The cancer risks for the maximally exposed member of the public and the onsite worker at SRS are also in excess of the typical threshold of regulatory concern of $1 \times 10^{-6}$. For details on the derivation of these HIs and cancer risks, see appendix table E.3.4–29 and summary table E.3.4–36.

*Tritium Supply and Recycling Upgrade.* There will be no radiological releases during the construction of upgraded tritium recycling facilities that are associated with all tritium supply technologies under consideration. Limited hazardous chemical releases are anticipated as a result of construction activities. However, their concentration will be within the regulated exposure limits and would not result in any adverse health effects. During normal operation, there would be both radiological and hazardous chemical releases to the environment and also direct in-plant exposures. The impacts from radiological and hazardous chemicals from each tritium supply technology are the summations of the impacts from the various facilities in operation for that technology.

The resulting doses and potential health effects to the public and workers from each technology are described below.

Radiological Impacts. Radiological impacts resulting from normal operation of various tritium supply technologies and upgraded recycling facilities at SRS are listed in table 4.6.3.9–1. The supporting analysis is provided in appendix section E.2.8.2.

The doses to the maximally exposed member of the public from annual site operation at SRS range from 2.5 mrem for both the APT with the helium-3 target and the Phased APT, to 4.1 mrem for the Large ALWR. From 40 years of operation, the corresponding risks of fatal cancer to this individual would range from $5.1 \times 10^{-5}$ to $8.1 \times 10^{-5}$. As a result of total site operations in the year 2030, the population doses would range from 220 to 340 person-rem for the same technologies, respectively. The corresponding numbers of fatal cancers in this population from 40 years of operation would range from 4.4 to 6.8.

The annual dose to the total site workforce would range from 510 person-rem for the MHTGR to 650 person-rem for the Large ALWR. The corresponding annual average doses to a site worker would be 33 mrem for the MHTGR, and 42 mrem for the Large ALWR. The risks and numbers of fatal cancers among workers from 40 years of operation are included in table 4.6.3.9–1.

Based on the radiological impacts associated with normal operation as described above, all of the tritium supply technologies and upgrade recycling facilities are acceptable for siting at SRS. All resulting doses are within radiological limits and are well below levels of natural background radiation.

Hazardous Chemical Impacts. Hazardous chemical impacts resulting from normal operation of tritium supply technologies at SRS are listed in table 4.6.3.9–2. HIs for the maximally exposed member of the public range from 0.07 (APT, HWR, and MHTGR) to 0.71 for the ALWR with a cancer risk of $3.3 \times 10^{-5}$ for all technologies due to No Action. The worker HIs for all technologies are 1.8 with cancer risks of $5.9 \times 10^{-3}$ due to No Action alone. Only the public HI value is within acceptable regulatory health limits. However, the cancer risk for workers at $5.9 \times 10^{-3}$ and the public at $3.3 \times 10^{-5}$ exceeds the typical threshold of regulatory concern of $1 \times 10^{-6}$. For details on the derivation of these HIs and cancer risks, see appendix tables E.3.4–30 through E.3.4–33, and summary table E.3.4–36.

*Tritium Recycling Facility Upgrade.*

Radiological Impacts. The tritium recycling facilities upgrade is described in section 3.4.3.2. The radiological impacts to the general public will not change from those of No Action with operation of the upgraded tritium recycling facilities. This is because upgrading will not change the radiological releases from the facility from those that would result from existing facilities. The radiological impacts to workers will effectively remain the same because the workforce associated with operations will change only slightly.

Hazardous Chemical Impacts. The impacts to the maximally exposed individual of the public and to the onsite worker resulting from normal operation of the upgraded tritium recycling facilities at SRS are listed in table 4.6.3.9–2. The calculated HI for the maximally exposed member of the public is $2.5 \times 10^{-6}$ with no cancer risk. The worker HI and cancer risk were calculated to be $2.8 \times 10^{-5}$ and 0, respectively. If the supply technologies were placed at a site other than SRS and the recycling upgrade was implemented at SRS, the hazardous chemical impact would either remain the same as No Action or show a slight reduction to workers and the public. This means that the HI for workers and cancer risks to the public and workers would exceed acceptable regulatory health limits due to the No Action contribution. It is to be noted, however, that the tritium recycling upgrade alone is well within the limits because the fraction it contributes is only $1/3.6 \times 10^{6}$ of the total risk. For details on the derivation of these HIs and cancer risks, see appendix tables E.3.4–34 and E.3.4–36.

*Tritium Recycling Phaseout.* If tritium recycling is performed at another site, existing recycling and extraction facilities at SRS would be phased out. The annual dose to the maximally exposed individual will decrease to a value that is 2.4 mrem less the No Action dose (table 4.6.3.9–1). The estimated risk of fatal cancer to this individual would decrease by $4.6 \times 10^{-5}$ over 40 years of total site operation. The elimination of the tritium recycling and extraction processes at SRS would also result in a decrease of 213 person-rem to the population within 50 miles in

**TABLE 4.6.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Savannah River Site* [Page 1 of 2]**

| Affected Environment | No Action | Tritium Supply Technologies and Recycling | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | HWR[a] | MHTGR[a] | ALWR[a] | | APT[a] | | | Tritium Recycling Upgrade | Tritium Recycling Phaseout |
| | | | | Large | Small | Full | | Phased | | |
| | | | | | | Helium-3 Target System | SILC Target System | Helium-3 Target System | | |
| **Maximally Exposed Individual (Public)** | | | | | | | | | | |
| ***Atmospheric Releases***[b] | | | | | | | | | | |
| Dose (mrem/yr)[c] | 2.8 | 3.4 | 3.0 | 3.9 | 3.6 | 2.5 | 2.8 | 2.5 | 2.0 | 0.47 |
| Percent of natural background[d] | 0.89 | 1.1 | 0.94 | 1.2 | 1.1 | 0.78 | 0.89 | 0.78 | 0.63 | 0.15 |
| 40-year fatal cancer risk | $5.6\times10^{-5}$ | $6.9\times10^{-5}$ | $5.9\times10^{-5}$ | $7.8\times10^{-5}$ | $7.1\times10^{-5}$ | $4.9\times10^{-5}$ | $5.6\times10^{-5}$ | $4.9\times10^{-5}$ | $4.0\times10^{-5}$ | $9.4\times10^{-6}$ |
| ***Liquid Releases*** | | | | | | | | | | |
| Dose (mrem/yr)[c] | 0.077 | 0.16 | 0.077 | 0.16 | 0.26 | 0.077 | 0.077 | 0.077 | 0.077 | 0.077 |
| Percent of natural background[d] | 0.024 | 0.052 | 0.024 | 0.052 | 0.084 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 |
| 40-year fatal cancer risk | $1.5\times10^{-6}$ | $3.3\times10^{-6}$ | $1.5\times10^{-6}$ | $3.3\times10^{-6}$ | $5.3\times10^{-6}$ | $1.5\times10^{-6}$ | $1.5\times10^{-6}$ | $1.5\times10^{-6}$ | $1.5\times10^{-6}$ | $1.5\times10^{-6}$ |
| ***Atmospheric and Liquid Releases***[b] | | | | | | | | | | |
| Dose (mrem/yr)[c] | 2.9 | 3.6 | 3.0 | 4.1 | 3.7 | 2.5 | 2.9 | 2.5 | 2.1 | 0.55 |
| Percent of natural background[d] | 0.91 | 1.1 | 0.97 | 1.3 | 1.2 | 0.81 | 0.91 | 0.81 | 0.66 | 0.17 |
| 40-year fatal cancer risk | $5.7\times10^{-5}$ | $7.2\times10^{-5}$ | $6.1\times10^{-5}$ | $8.1\times10^{-5}$ | $7.5\times10^{-5}$ | $5.1\times10^{-5}$ | $5.7\times10^{-5}$ | $5.1\times10^{-5}$ | $4.1\times10^{-5}$ | $1.1\times10^{-5}$ |
| **Population Within 50 Miles** | | | | | | | | | | |
| ***Atmospheric and Liquid Releases*** | | | | | | | | | | |
| ***Year 2030*** | | | | | | | | | | |
| Dose (person-rem) | 250 | 300 | 260 | 340 | 310 | 220 | 250 | 220 | 180 | 37 |
| Percent of natural background[d] | 0.11 | 0.13 | 0.11 | 0.15 | 0.13 | 0.093 | 0.11 | 0.093 | 0.075 | 0.016 |
| 40-year fatal cancers | 4.9 | 6.1 | 5.2 | 6.8 | 6.2 | 4.4 | 4.9 | 4.4 | 3.6 | 0.73 |

**TABLE 4.6.3.9–1.—*Potential Radiological Impacts to the Public and Workers Resulting from Normal Operation of Tritium Supply Technologies and Recycling at Savannah River Site* [Page 2 of 2]**

| Affected Environment | No Action | Tritium Supply Technologies and Recycling | | | | | | | Tritium Recycling Upgrade | Tritium Recycling Phaseout |
|---|---|---|---|---|---|---|---|---|---|---|
| | | HWR[a] | MHTGR[a] | ALWR[a] | | APT[a] | | | | |
| | | | | Large | Small | Full | | Phased | | |
| | | | | | | Helium-3 Target System | SILC Target System | Helium-3 Target System | | |
| **Workers Onsite** | | | | | | | | | | |
| Average worker dose (mrem/yr)[c] | 32 | 34 | 33 | 42 | 38 | 34 | 34 | 34 | 4 | 32 |
| Fatal cancer risk | $5.2\times10^{-4}$ | $5.4\times10^{-4}$ | $5.3\times10^{-4}$ | $6.7\times10^{-4}$ | $6.1\times10^{-4}$ | $5.4\times10^{-4}$ | $5.4\times10^{-4}$ | $5.4\times10^{-4}$ | $6.5\times10^{-5}$ | $5.2\times10^{-4}$ |
| Total workforce dose (person-rem/yr) | 480 | 520 | 510 | 650 | 580 | 533 | 534 | 533 | 1.6 | 480 |
| 40-year fatal cancers | 7.7 | 8.3 | 8.2 | 10.0 | 9.3 | 8.5 | 8.5 | 8.5 | 0.026 | 7.7 |

[a] Includes the impacts from No Action facilities which includes existing tritium recycling. Existing tritium recycling and upgraded tritium recycling result in the same impacts.

[b] The location of the maximally exposed individual varies depending on the tritium supply technology.

[c] The applicable radiological limits for an individual member of the public are 10 mrem/per year resulting from site operations for the air pathways, 4 mrem from the drinking water pathway, and 100 mrem/per year from all pathways combined (DOE Order 5400.5) The radiological limit for an individual worker is 5,000 mrem/per year (40 CFR 835).

[d] Natural background levels: to the average individual is 315 mrem/per year; to the population in the year 2030 is 233,300 person-rem.

Note: SILC - spallation-induced lithium conversion.

Note: Model results. See appendix sections E.2.2, E.2.8, and E.2.8.2.

**TABLE 4.6.3.9–2.—*Potential Hazardous Chemical Impacts to the Public and Workers Resulting from Normal Operation at Savannah River Site***

| Health Impact | No Action | Tritium Supply Technologies | | | | Tritium Recycling Upgrade |
|---|---|---|---|---|---|---|
| | | HWR[a] | MHTGR[a] | ALWR[a] | APT[a] | |
| **Maximally Exposed Individual (Public)** | | | | | | |
| Hazard Index | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | $2.5\times10^{-6}$ |
| Cancer risk | $3.2\times10^{-5}$ | $3.2\times10^{-5}$ | $3.2\times10^{-5}$ | $3.2\times10^{-5}$ | $3.2\times10^{-5}$ | 0 |
| **Worker Onsite[b]** | | | | | | |
| Hazard Index | 1.8 | 1.8 | 1.8 | 1.9 | 1.8 | $2.8\times10^{-5}$ |
| Cancer risk | $5.9\times10^{-3}$ | $5.9\times10^{-3}$ | $5.9\times10^{-3}$ | $5.9\times10^{-3}$ | $5.9\times10^{-3}$ | 0 |

[a] Includes impacts from No Action.

[b] The Hazard Index for the onsite worker is computed by using the permissible exposure limit as the denominator rather than the reference concentration which is used for the maximally exposed member of the public (appendix E).

Note: Model result. See appendix table E.3.4–1.

the year 2030, and 4.2 fewer fatal cancers over 40 years of operation compared with continued No Action operation. The doses and associated health effects among workers would remain virtually the same as for No Action.

Hazardous Chemical Impacts. The impacts to the maximally exposed individual of the public and to the onsite worker resulting from normal operation with a phaseout of the tritium recycling function are listed in table 4.6.3.9–2. The calculated HI for the maximally exposed member of the public is 0.70 with a cancer risk of $3.3 \times 10^{-5}$. The worker HI and cancer risk were calculated to be 1.8 and $5.9 \times 10^{-3}$, respectively. The HI for the maximally exposed member of the public is within the acceptable regulatory health limits based on EPA's regulations for public exposure limits during an 8 hour work period. The cancer risks for both the maximally exposed member of the public and onsite workers exceed the typical threshold of regulatory concern of $1 \times 10^{-6}$. For details on the threshold of these HIs and cancer risks, see appendix table E.3.4–35 and summary table E.3.4–36.

*Less Than Baseline Operations.* The normal operation radiological impacts for the HWR operating at reduced tritium production capacity to meet a less than baseline operations requirement would be proportioned to the level of operation (approximately 50 percent of baseline). The MHTGR or ALWR normal operation radiological impacts would not change because the reactor would maintain power requirements to produce steam or electricity.

The Phased APT is already less than the baseline tritium requirement and thus the impacts are as presently given in the PEIS.

*Potential Mitigation Measures.* Radioactive and hazardous chemical airborne emissions to the general population and onsite exposures to workers could be reduced by implementing the latest technology for process and design improvements. For example, to reduce public exposure from emissions, improved methods could be used to remove radioactivity from the releases to the environment. Similarly, the use of remote, automated, and robotic production methods are examples of techniques that are being developed which could reduce worker exposure. Substitution of less toxic/noncancer causing solvents would result in reductions of the HI and possible complete elimination of the cancer risk.

The incorporation of an alternate upgraded tritium recycling plant, which would include transferring certain functions to the Replacement Tritium Facility, would reduce the annual release of airborne tritium by 12,000 Ci. This would result in annual dose reductions of 0.8 mrem to the maximally exposed member of the public and 70 person-rem to the 50-mile population for each tritium supply technology. For example, the corresponding annual doses associated with the HWR alternative would decrease from 3.5 mrem to 2.7 mrem, and from 300 to 230 person-rem. For 40 years of operations, the annual dose reductions would project to a decreased fatal cancer risk to the individual of $1.6 \times 10^{-5}$ and 1.4 fewer fatal cancers in the population for each supply alternative.

**Facility Accidents.**

*No Action.* Under No Action, tritium recycling will continue to be performed in Building 233-H, the Replacement Tritium Facility. All reactors previously used for tritium production operations have already been shut down.

The potential accidents and their consequences are documented in safety analysis reports that have been prepared for the existing tritium recycling facilities. The major hazards associated with the operation of these facilities is the release of tritium to the environment. Other facilities at SRS such as the F- and H-Canyons, Defense Waste Processing Facility, Plutonium Fuel Fabrication Facility, Receiving Basin for Off-Site Fuel and various laboratories will continue to operate or be shut down. Potential accidents and consequences for these facilities are documented in existing safety analysis reports.

As shown in table 4.6.3.9–3, the highest consequence accident under No Action for tritium operation would be an earthquake-induced leak/ignition and fire in the Unloading Station Carousel A Reservoir. The analysis postulated the release of $8.4 \times 10^{6}$ Ci of tritium in oxide form to the environment. If this accident occurred, it could result in 0.15 cancer fatalities to the population within 50 miles of the site. The risk of this accident, that takes both accident

probability and consequence into account, would be approximately $3.0 \times 10^{-6}$ cancer fatalities per year for the same population.

**TABLE 4.6.3.9–3.—*Radioactive Release Accidents and Consequences for Existing No Action Tritium Recycling Operations at Savannah River Site***

| Accident Description | Beyond Design-Basis Earthquake |
|---|---|
| Accident frequency (per year) | $2.0 \times 10^{-5}$ |
| **Consequence** | |
| ***Maximally Exposed Individual*** | |
| Dose (rem) | 0.045 |
| Cancer fatalities | $1.0 \times 10^{-6}$ |
| Risk (cancer fatalities per year) | $2.0 \times 10^{-11}$ |
| ***Population Within 50 Miles*** | |
| Dose (person-rem) | 300 |
| Cancer fatalities | 0.15 |
| Risk (cancer fatalities per year) | $3.0 \times 10^{-6}$ |

Note: Model results.

Figure 4.6.3.9–1 shows the number of latent cancer fatalities that may result for each technology, including tritium extraction and recycling, if an accident were to occur. Specifically, each curve in the figure shows the conditional probability (vertical axis) that the number of cancer fatalities (horizontal axis) will be exceeded if the accident occurred. The curves do not reflect the probability of the accident.

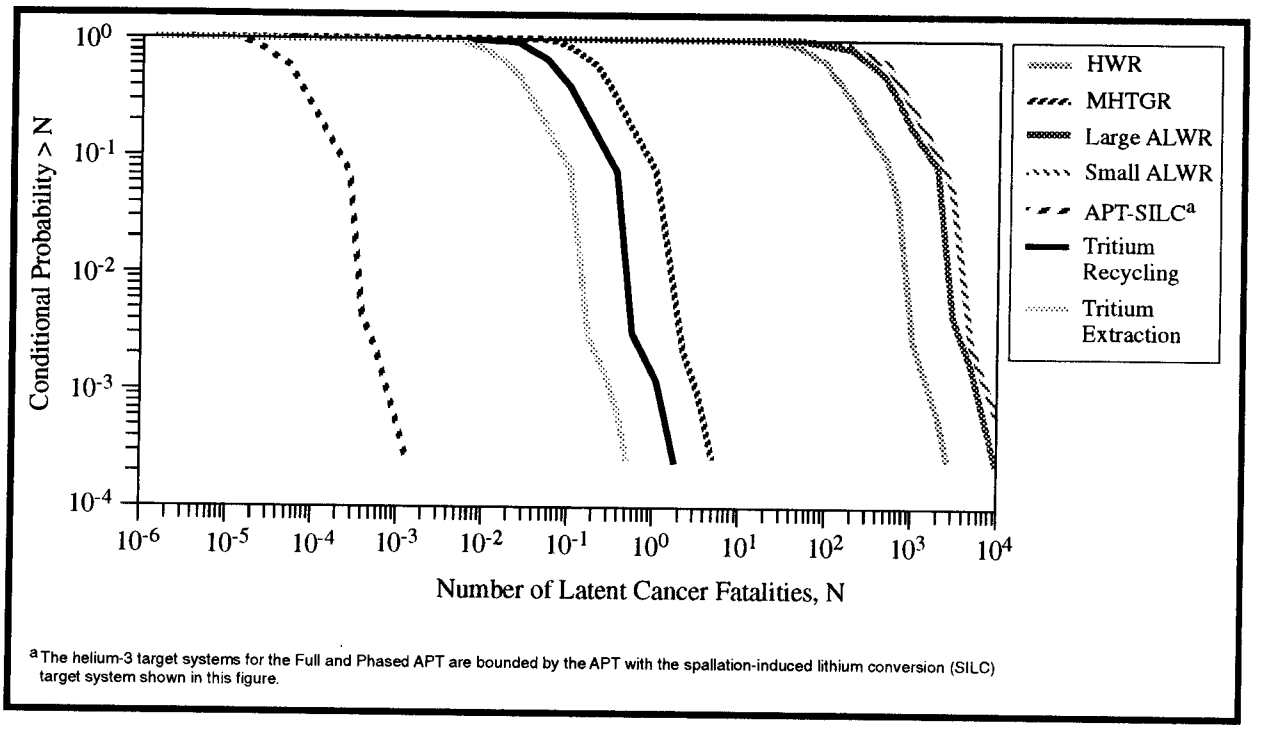
The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be reduced; recreational areas may be closed; industrial parks may suffer economic losses; historical sites may have to be closed to visitors; and endangered species may move closer to extinction. In the region of the SRS, the natural background level of radiation (excluding radon) is 76 mrem per year. For a hypothetical design basis accidental release, the radiation levels exceeding 76 mrem per year are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $2.9 \times 10^{7}$ square meters (7,166 acres).

*Tritium Supply Alone.* The proposed action at SRS has the potential for accidents that may impact the health and safety of workers and the public. The potential for and associated consequences of reasonably foreseeable accidents have been assessed for each technology at SRS and are summarized in this section and described in more detail in appendix F. The methodology used in the assessment is described in section 4.1.9.

The potential impacts from accidents, ranging from high-consequence/low-probability to low-consequence/high-probability events, have been evaluated in terms of the number of cancer fatalities that may result. The risk of cancer fatalities has also been evaluated to provide an overall measure of an accident's impacts and is calculated by multiplying the accident annual frequency (or probability) of occurrence by the consequences (number of cancer fatalities).

Analyses of postulated accidents for the tritium supply facilities at SRS indicate that, for the high consequence accident, the estimated risk of cancer fatalities to the public within 50 miles of the site due to the accidental release of radioactive material or chemicals would be $2.0 \times 10^{-5}$ cancer fatalities per year (table 4.6.3.9–4). This accident risk, which corresponds with the ALWR, is low when compared to the risk of cancer fatalities to the same population from all other causes.

Details on the range of accidents for the tritium supply technologies at SRS are presented in appendix F. Each of the technologies has been analyzed from the standpoint of identifying the consequences of design-basis/operational accidents (using the GENII Code) and beyond design basis, or severe accidents (using the MACCS computer code). The severe accident consequences are shown in table 4.6.3.9–4 for each technology. The table also shows the consequences of each accident for the population and for an individual who may be located at the site boundary. The results of the analysis indicate that the tritium supply technology with the highest severe accident consequence is the ALWR.




[a] The helium-3 target systems for the Full and Phased APT are bounded by the APT with the spallation-induced lithium conversion (SILC) target system shown in this figure.

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**FIGURE 4.6.3.9–1.—*High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Functions for Tritium Supply and Recycling Severe Accidents at Savannah River Site.***

The technology with the lowest accident consequence is the APT with the helium-3 target system. The APT accident consequences are significantly lower than the HWR, MHTGR, and ALWR consequences. Upgraded tritium recycling facilities are common to all tritium supply technologies but, except for the APT, the accident consequences are dominated by reactor accidents. The tritium extraction facility accident dominates the accelerator accidents.

Heavy Water Reactor. A set of accident sequences with a release category in which there is a reactor isolation failure with containment spray failed was postulated. In the event that this accident were to occur, there would be an estimated 222 cancer fatalities in the population within 50 miles and a cancer fatality risk of $1.2 \times 10^{-3}$ to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is less than $1.1 \times 10^{-5}$ cancer fatalities per year (table 4.6.3.9–4).

Modular High Temperature Gas-Cooled Reactor. A set of accident sequences with a release category in which there is a depressurized conduction cooldown without the reactor cavity cooling system functioning was postulated. This would be a high consequence accident for the MHTGR. In the event that this accident were to occur, there would be an estimated 0.40 cancer fatalities in the population within 50 miles and an increased likelihood of a cancer fatality of $2.3 \times 10^{-6}$ to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is $2.4 \times 10^{-8}$ cancer fatalities per year (table 4.6.3.9–4).

Advanced Light Water Reactor. A range of accident sequences with various release categories was analyzed for the ALWR. One release category for a Large ALWR and one for a Small ALWR were selected to represent the accident consequences for an ALWR (appendix section F.2.1.3). In the event that such an accident were to occur, there would be an estimated 808 cancer fatalities for a Large ALWR and 984 cancer fatalities for a Small ALWR in the population within 50 miles and a cancer risk of $4.6 \times 10^{-3}$ for a Large ALWR, and $5.3 \times 10^{-3}$ for a Small ALWR to an individual who may be located at the site boundary. The risk to the population, that takes the probability of the accident into account, is $1.6 \times 10^{-5}$ cancer fatalities per year for a Large ALWR and $2.0 \times 10^{-5}$ cancer fatalities per year for a Small ALWR (table 4.6.3.9–4).

Accelerator Production of Tritium with Helium-3 Target System. The large break loss of coolant accident with the total loss of the active emergency cooling system and the heat sink was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $3.4 \times 10^{-5}$ fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $2.3 \times 10^{-10}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $3.4 \times 10^{-9}$ cancer fatalities per year (table 4.6.3.9–4).

Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System. The large break loss of coolant accident with a successful beam trip and the total loss of the active emergency cooling system was postulated as the high consequence accident for this APT and target option. In the event that this accident were to occur, there would be an estimated $2.2 \times 10^{-4}$ cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.7 \times 10^{-9}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $2.2 \times 10^{-8}$ cancer fatalities per year (table 4.6.3.9–4).

*Tritium Target Extraction and Recycling Facility Upgrade.* The tritium extraction facility is required to support all tritium supply technologies except the APT technology with the helium-3 target system. The tritium recycling facility upgrade at SRS is required to support all tritium supply technologies. The analyses of postulated high consequence accidents for the tritium extraction and recycling facilities at SRS are presented below.

Tritium Target Extraction Facility. An earthquake and release of process vessel tritium inventory was postulated as the high consequence accident. In the event that this accident were to occur, there would be an estimated 0.043 cancer fatalities in the population within 50 miles and a cancer fatality risk of $2.8 \times 10^{-7}$ to an individual who may be located at the site boundary. The risk to the population, taking the probability of the accident into account, is less than $6.0 \times 10^{-6}$ cancer fatalities per year (table 4.6.3.9–4).

Tritium Recycling Facility. An earthquake induced leak/ignition and fire in the unloading station carousel reservoir was postulated as the high consequence accident for the tritium recycling facility. In the event that this accident were to occur, there would be an estimated 0.15 cancer fatalities in the population within 50 miles and an increased likelihood of cancer fatality of $1.0 \times 10^{-6}$ to an individual located at the site boundary during the accident. The risk to the population, that takes the probability of the accident into account, is on the order of $3.0 \times 10^{-6}$ cancer fatalities per year.

Tritium Recycling Facility Upgrade. Upgrade of the existing tritium recycling facilities at SRS may change the existing risks of accidents. Under upgrade, all tritium recycling facilities would be brought into compliance with DOE orders and other applicable regulations and standards. This may result in a reduction of risk compared to No Action.

For comparison purposes with high consequence tritium supply facility accidents, for the same total population of 773,000 in the year 2050 within 50 miles of the site, there is a risk of 1,550 cancer fatalities per year from all other natural causes.

The analysis of facility accidents for tritium supply technologies at SRS shows that, for high consequence accidents analyzed using MACCS computer code, the ALWR has the highest consequences and risk and the APT has the lowest consequences and risk. The risk of accidents for any of the tritium supply technologies, tritium extraction, and tritium recycling facilities common to all technologies is low when compared to the human risk of cancer from all other causes.

The consequence of the operational basis or design basis accident for the tritium extraction facility at SRS is shown in table 4.6.3.9–5. The results in table 4.6.3.9–5 should not be compared with the severe accident analysis results in table 4.6.3.9–4 because different computer codes using different calculational approaches were used.

*Less Than Baseline Operations.*

Facility Accidents. Less than baseline tritium operation would have no significant change to the current accident analyses consequences for the HWR unless the baseline HWR core design was downsized.

**TABLE 4.6.3.9–4.—*Tritium Supply Technologies and Target Extraction High Consequence/Low Probability Radioactive Release Accidents and Consequences at Savannah River Site***

| Parameter | Tritium Supply Technologies | | | | | | Tritium Target Extraction Facility[d] | Tritium Recycling Facility |
|---|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR[c] | | APT | | | |
| | | | Large | Small | Full/Phased | Phased | | |
| | | | | | Helium-3 Target System[e,f] | SILC Target System[g,h] | | |
| **Accident** | | | | | | | | |
| Frequency (per year) | $5.0 \times 10^{-8}$ | $6.0 \times 10^{-8}$ | $2.0 \times 10^{-8}$ | $2.0 \times 10^{-8}$ | $1.0 \times 10^{-4}$ | $1.0 \times 10^{-4}$ | $1.4 \times 10^{-4}$ | $2.0 \times 10^{-5}$ |
| **Consequence** | | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | | |
| Dose (rem) | 45 | $8.3 \times 10^{-2}$ | 174 | 174 | $1.1 \times 10^{-5}$ | $1.2 \times 10^{-4}$ | 0.013 | 0.045 |
| Cancer fatalities | $1.2 \times 10^{-3}$ | $2.3 \times 10^{-6}$ | $4.6 \times 10^{-3}$ | $5.3 \times 10^{-3}$ | $2.3 \times 10^{-10}$ | $1.7 \times 10^{-9}$ | $2.8 \times 10^{-7}$ | $1.0 \times 10^{-6}$ |
| Risk (cancer fatalities per year) | $6.1 \times 10^{-11}$ | $1.4 \times 10^{-13}$ | $9.1 \times 10^{-11}$ | $1.1 \times 10^{-10}$ | $2.3 \times 10^{-14}$ | $1.7 \times 10^{-13}$ | $3.9. \times 10^{-11}$ | $2.0 \times 10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | | |
| Dose (person-rem) | $4.4 \times 10^{5}$ | 800 | $1.6 \times 10^{6}$ | $2.0 \times 10^{6}$ | 0.068 | 0.43 | 86 | 300 |
| Cancer fatalities | 222 | 0.40 | 808 | 984 | $3.4 \times 10^{-5}$ | $2.2 \times 10^{-4}$ | 0.043 | 0.15 |
| Risk (cancer fatalities per year) | $1.1 \times 10^{-5}$ | $2.4 \times 10^{-8}$ | $1.6 \times 10^{-5}$ | $2.0 \times 10^{-5}$ | $3.4. \times 10^{-9}$ | $2.2 \times 10^{-8}$ | $6.0 \times 10^{-6}$ | $3.0 \times 10^{-6}$ |

[a] For detailed HWR accident discussion see appendix section F.2.1.1.
[b] For detailed MHTGR accident discussion see appendix section F.2.1.2.
[c] For detailed ALWR accident discussion see appendix section F.2.1.3.
[d] For detailed tritium target extraction facility discussion, see appendix section F.2.1.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.
[e] For detailed APT with helium-3 target system discussion, see appendix section F.2.1.4.2.
[f] Analysis postulated the total failure of the active emergency cooling system and the loss of the heat sink.
[g] For detailed APT with spallation-induced lithium conversion target system discussion, see appendix section F.2.1.4.3.
[h] Analysis postulated successful beam trip with the total failure of the active emergency cooling system.
Note: Model results.

The baseline HWR configuration would adjust to the reduced target through-put requirements by reducing the time that the reactor is required to operate at 100 percent power. It is not anticipated that the overall risk from operating the reactor in this mode would decrease significantly. Accident analyses have not been performed to address accident sequences and initiating events when the reactor is in the cold shut down mode. In addition, operator error has a significant effect on facility risk and if the reactor is shut down a high percentage of the time, operator error may actually increase when the reactor is at power.

Less than baseline tritium operations would have no significant change to the current accident analyses consequences for the ALWR. The reactor surplus capacity would be used to generate steam for electric power production.

Less than baseline tritium operation would have no change to the MHTGR accident analyses because the analyses assumed that only one of the reactor modules would be involved in the accident.

Less than baseline tritium operation would have no significant change to the APT accident analyses consequences. The accident consequences for Full and Phased APT accidents with low to moderate consequences were negligible. For the beyond design basis accident, there was no difference in the Full and the Phased accident consequences. Review of the source terms for the Full and the Phased APT indicated that the tritium component of the source term is identical for both accidents. Review of the MACCS computer code output data for each accident analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results is negligible.

*Potential Mitigation Measures.* The accidents postulated for tritium supply technologies and upgraded recycling facilities are based on operation and safety analyses that have been performed at similar facilities. One potential mitigation measure is to transfer certain tritium extraction activities from Building 232-H to the Replacement Tritium Facility, Building 233-H, to take advantage of improved safety and other new technology features in the Replacement Tritium Facility. This transfer would result in additional sources of tritium in the Replacement Tritium Facility and the potential for additional risk of accidents. This additional risk in the Replacement Tritium Facility is offset by the elimination of a higher risk of performing these activities in the older facilities of Building 232-H. If these activities were transferred to the Replacement Tritium Facility, the change would have to be examined from the standpoint of *Unreviewed Safety Questions* in accordance with DOE Order 5480.21 to determine if the authorization basis for the facility has changed. If the authorization basis changes, operational restrictions are placed on the facility until detailed safety evaluations are completed. One of the major design goals for a tritium supply and recycling facilities is to achieve a reduced risk to facility personnel and to public health and safety to as low as reasonably achievable.

Worker exposures that may result from the accidental release of radioactive material will be minimized through design features and administrative procedures that will be defined in conjunction with the facility design process. The radiological impacts to workers from accidents could not be estimated for this PEIS because the facility design information needed to support the estimate has not yet been developed. The impacts on workers from accidents will be analyzed as part of subsequent project-specific NEPA documentation and in detailed safety analysis documentation that are prepared in conjunction with the facility design process.

The tritium supply and upgraded recycling facilities would be designed to comply with current Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide facilities that are highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, and high wind, as well as credible events as appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity for containing materials.

The tritium supply facility would be designed to resist the effects of severe natural phenomena as well as the effects of man-made threats to its continuing structural integrity. It also would be designed to provide containment of the tritium inventory at all times through the use of multiple, high quality confinement barriers to prevent the accidental release of tritium to the environment. It also would be designed to produce a lower quantity of waste materials as

**TABLE 4.6.3.9–5.—*Tritium Supply Technologies and Recycling Low to Moderate Consequence Radioactive Release Accidents and Consequences at Savannah River Site***

| Parameter | Tritium Supply Technologies | | | | | Tritium Target Extraction Facility[e] | Tritium Recycling Facility |
|---|---|---|---|---|---|---|---|
| | HWR[a] | MHTGR[b] | ALWR/Large[c] | ALWR/Small | APT[d] SILC Target System | | |
| **Accident** | | | | | | | |
| Description | Fuel assembly failure during charge and discharge operations | Large break in primary system piping | Large break loss of coolant accident | Large break loss of coolant accident | Large break loss of coolant accident[f] | Deflagration[g] | Hydride Bed Rupture |
| Frequency (per year) | 0.01 | 0.01 | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $1.0 \times 10^{-3}$ | $2.0 \times 10^{-5}$ | $2.0 \times 10^{-4}$ |
| **Consequence** | | | | | | | |
| ***Maximally Exposed Individual*** | | | | | | | |
| Dose (rem) | 0.046 | 0.059 | 14.0 | 0.64 | negligible | 0.23 | $9.9 \times 10^{-4}$ |
| Cancer fatalities | $2.3 \times 10^{-5}$ | $3.0 \times 10^{-5}$ | $7.1 \times 10^{-3}$ | $3.2 \times 10^{-4}$ | negligible | $1.2 \times 10^{-4}$ | $4.9 \times 10^{-7}$ |
| Risk (cancer fatalities per year) | $2.3 \times 10^{-7}$ | $3.0 \times 10^{-7}$ | $7.1 \times 10^{-6}$ | $3.2 \times 10^{-7}$ | negligible | $2.4 \times 10^{-9}$ | $9.8 \times 10^{-11}$ |
| ***Population Within 50 Miles*** | | | | | | | |
| Dose (person-rem) | $1.5 \times 10^{3}$ | $2.0 \times 10^{3}$ | $4.6 \times 10^{5}$ | $2.1 \times 10^{4}$ | negligible | $1.2 \times 10^{4}$ | 49.0 |
| Cancer fatalities | 0.74 | 1.0 | 230.0 | 11.0 | negligible | 6.0 | 0.025 |
| Risk (cancer fatalities per year) | $7.4 \times 10^{-3}$ | 0.01 | 0.23 | 0.011 | negligible | $1.2 \times 10^{-4}$ | $5.0 \times 10^{-6}$ |

[a] For detailed HWR accident discussion, see appendix section F.2.2.1.

[b] For detailed MHTGR accident discussion, see appendix section F.2.2.2.

[c] For detailed ALWR accident discussion, see appendix section F.2.2.3.

[d] The APT with helium-3 target system bounding low to moderate consequence accident consequences are bounded by the APT with spallation-induced lithium conversion target system, which are nil. For detailed APT discussion, see appendix section F.2.2.4.

[e] For detailed tritium target extraction facility discussion, see appendix section F.2.2.5. The tritium target extraction facility is required for the HWR, MHTGR, ALWR, and the APT with spallation-induced lithium conversion target system tritium supply configurations and not required for the APT with helium-3 target system tritium supply configuration.

[f] Analysis postulated all plant protection systems functioned as designed.

[g] Intense rapid burning.

Note: SILC - spallation-induced lithium conversion.

Note: Model results.

compared to the tritium facilities of the existing weapons complex.

In addition, DOE orders specify the requirements for emergency preparedness at DOE facilities. SRS has comprehensive emergency plans to protect life and property within the facility and the health and welfare of surrounding areas. The emergency plans would be revised to incorporate future DOE requirements and expanded to incorporate the addition of tritium supply facilities to SRS. See section 4.6.2.9 for emergency preparedness and emergency plan details at SRS.

#### 4.6.3.10 *Waste Management*

Construction and operation of tritium supply and upgrading recycling facilities would impact existing SRS waste management operations, increasing the generation of low-level, mixed low-level, hazardous, and nonhazardous wastes, and reintroducing the generation of spent nuclear fuel. There are no high-level or TRU wastes associated with the proposed action. All reactor technologies would provide treatment and storage of spent fuel for the life of the facility. Spent nuclear fuel would be managed in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS.*

The impacts of a decision to use existing facilities would range from filling onsite LLW disposal facilities at the rate of 13 acres per year; utilizing 50 percent of the capacity of the liquid LLW treatment facilities; increasing the generation of mixed LLW to a rate that would fill the storage facilities in half of their planned lifetime; and increasing the quantity of hazardous waste generated by a factor of nine requiring new RCRA-permitted staging facilities. The reactor technologies produce liquid LLW in quantities requiring new treatment facilities, and all technologies require expanded or new treatment facilities for their liquid sanitary wastes. This section provides a description of the waste generation, treatment, storage, and disposal requirements of the tritium supply technologies and upgraded recycling facilities and the potential impact on waste management activities at SRS.

**No Action.** Under No Action, high-level, TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes and spent nuclear fuel would continue to be managed from the missions outlined in section 3.3.5. Table 4.6.3.10–1 lists the projected waste generation rates as well as treatment, storage, and disposal capacities under No Action. Projections for No Action were derived from 1991 environmental data, with appropriate adjustments made for those changing operational requirements where the volume of wastes generated is identifiable. These wastes could be managed adequately by existing and currently planned facilities. The projection does not include wastes from yet uncharacterized environmental restoration activities.

Spent nuclear fuel from past production reactor operations will have been stabilized and stored onsite awaiting the availability of a Federal repository. Since the K-Reactor is in a cold standby with no provision for restart, there will be no additional spent reactor fuel generated. However, SRS may continue to receive spent nuclear fuel from offsite facilities. This fuel would be stabilized and prepared for long-term storage onsite. Spent nuclear fuel would be managed in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS.*

TRU waste previously stored or buried would be repackaged to meet WIPP waste acceptance criteria and stored in the Solid Waste Disposal Facility for eventual shipment to WIPP once it is demonstrated to be in compliance with the requirements of 40 CFR 191 and 40 CFR 268 or to another TRU waste disposal facility should WIPP prove unsatisfactory. If additional treatment is necessary for disposal at WIPP, SRS would develop the appropriate treatment capability. If shipments to WIPP are delayed, additional storage facilities would be designed and constructed as needed.

Liquid LLW would be processed into saltstone and disposed of in engineered facilities onsite. Solid LLW would be compacted and disposed of in engineered trenches. The planned burial ground expansion in the E-Area is expected to accommodate the current waste disposal requirements through 2012. Additional waste disposal facilities would be

constructed as needed to ensure compliance. The Consolidated Incineration Facility would also be utilized to reduce the volume of LLW requiring disposal. Specifics of this additional LLW disposal capacity would be addressed in site-specific tiered NEPA documents.

SRS plans to incinerate mixed waste in compliance with applicable RCRA Land Disposal Restriction Standards, stabilize it, and dispose of the residue onsite as LLW. These processes are under development in accordance with terms and schedules of the Federal Facility Compliance Agreement on RCRA Land Disposal Restrictions signed by DOE and EPA on March 13, 1991. Details of this agreement are provided in appendix section A.2.5. This agreement is being reviewed in light of the *Federal Facility Compliance Act* which requires DOE to submit a site-specific treatment plan to the State of South Carolina to address compliance with RCRA Land Disposal Restrictions for mixed waste. At the present time, mixed waste is stored in a RCRA-permitted facility in DOT-approved containers until treatment capacity becomes available.

SRS also plans to incinerate hazardous waste in compliance with applicable RCRA incinerator permit and RCRA Land Disposal Restriction Standards, and NESHAPs (hazardous air pollutants) and New Source Performance Standards of the CAA onsite (in the Consolidated Incineration Facility), stabilize it, and dispose of the residue onsite. A RCRA-permitted hazardous waste storage and disposal facility is currently being designed to handle projected wastes from current operations. Specific areas are being reserved for future expansion. Offsite disposal (current practice) would remain an option. Specifics of this hazardous waste incineration and/or shipment to offsite commercial, RCRA-permitted facilities would be addressed in site-specific tiered NEPA documents.

Sanitary and nonhazardous process waste liquids are treated by various means to remove water and must comply with two CWA settlement agreements discussed in appendix section A.1.5. Disposal of the treated sanitary and process water is addressed in section 4.6.3.4. The resultant solids are disposed of with solid nonhazardous waste in a permitted landfill sized to handle projected future waste volumes. The current sanitary waste landfill is nearing design capacity. Disposal offsite in a permitted commercial facility is being considered for the future.

**Tritium Supply and Recycling.** Tritium supply and upgraded recycling facilities would treat and package all waste generated in support of the nuclear weapons stockpile into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2. The resultant waste effluents are shown in section 3.4. Since tritium recycling is a mission already performed at SRS, the incremental waste volumes would come from the new tritium supply facility. Waste generated during construction of any tritium supply technology would consist of wastewater, solid nonhazardous, and hazardous waste. The nonhazardous wastes would be disposed of as part of the construction project by the contractor, and the hazardous wastes would be shipped to a RCRA-permitted treatment and disposal facility. Operation of the three reactor-based tritium supply technologies would generate spent fuel, and all four technologies and the upgraded tritium recycling facilities would generate low-level, mixed low-level, hazardous, and nonhazardous wastes. The volume of the waste streams from tritium supply would vary according to the tritium supply technology chosen. Table 4.6.3.10–2 lists the total estimated waste volumes projected to be generated at SRS as a result of various tritium supply technologies and upgraded recycling facilities. The incremental waste volumes from the tritium supply technologies that were added to the tritium recycling phaseout projection can be found in appendix section A.2. The phaseout projection was derived by subtracting the unconsolidated recycling upgrade volumes from No Action.

Table 4.6.3.10–3 lists potential waste management impacts at SRS at the time of initial operation of the tritium facilities. Spent nuclear fuel storage for the life of the reactors is provided for in the reactor designs (appendix section A.2.1). The interim management of spent nuclear fuel (pending the availability of a geologic repository) would be in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS*. Because spent nuclear fuel reprocessing is not planned, no HLW would be generated.

Without plutonium production, no TRU waste would be generated. The treatment, storage, and disposal of mixed LLW would be in accordance with the *SRS Site Treatment Plan* which is currently being developed pursuant to the *Federal Facility Compliance Act.*

*Heavy Water Reactor.* Spent nuclear fuel would be generated at the rate of 7 $yd^3$per year. The HWR would be designed to provide the necessary treatment and storage for the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the HWR would require treatment facilities to reduce LLW volume and stabilize the remaining concentrated radionuclides to prepare it for disposal onsite. The solid LLW generated would double the No Action volume, and require 12 acres per year of additional onsite LLW disposal area (assuming a 4,300 $ft^3$ per acre disposal usage factor). There would be no increase in liquid mixed LLW generated, but the solid mixed LLW volume would increase by 79 percent over No Action. Expansion of existing or planned, or new treatment facilities may be required. The HWR would generate hazardous waste at a rate that is 4 times that of No Action. Thus, appropriate RCRA-permitted staging facilities would be planned for the HWR. A factor of 14 increase in liquid sanitary wastes generation would require new treatment facilities. The 10 percent increase in solid sanitary wastes would reduce the life of the landfill or require its expansion.

*Modular High Temperature Gas-Cooled Reactor.* Spent nuclear fuel would be generated at the rate of 80 $yd^3$ per year. The MHTGR would be designed to provide the necessary treatment and storage for the spent nuclear fuel while awaiting final disposition. The liquid LLW generation would require treatment facilities to concentrate and stabilize the radionuclides for disposal onsite. Solid LLW generation would increase by 25 percent over No Action, requiring 3 acres per year of additional new disposal area. There would be no increase in liquid mixed LLW generation, and the solid mixed LLW generation would be less than 1 percent more than No Action; therefore no impacts are expected. The MHTGR does generate solid hazardous waste at a rate that is eight times that of No Action. Additional facilities would be required where this waste could be accumulated and prepared for shipment to a RCRA-permitted disposal facility. A factor of 10 increase in liquid sanitary wastes would require new treatment facilities. Solid sanitary waste generation would increase by 9 percent, reducing the life of the landfill or requiring its expansion.

*Advanced Light Water Reactor (Large).* Spent nuclear fuel would be generated at the rate of 30 $yd^3$ per year. The Large ALWR would be designed to provide the necessary treatment for the spent fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require treatment facilities to concentrate and stabilize the radionuclides for disposal onsite. The solid LLW generated would be 14 percent more than the No Action volume. This would require 3.5 acres of additional LLW disposal area per year. There would be no increase in liquid mixed LLW generated by the ALWR; however, the solid mixed LLW volume would be 4 percent more than No Action. Some expansion of planned treatment facilities may be required. The ALWR would cause hazardous waste generation to increase by a factor of four. Additional RCRA-permitted facilities may be required to prepare the waste for shipment to a RCRA-permitted disposal facility. Liquid sanitary wastes generated by the ALWR would increase 35 times the No Action volumes. This would require expansion of existing facilities, or the construction of new facilities. Solid sanitary wastes increase the No Action volumes by 9 percent, reducing the life of the landfill or requiring its expansion.

*Advanced Light Water Reactor (Small).* Spent nuclear fuel would be generated at the rate of 15 $yd^3$ per year. The Small ALWR would be designed to provide the necessary treatment for the spent nuclear fuel while awaiting final disposition. The liquid LLW generated by the ALWR would require treatment facilities to reduce its volume and stabilize the remaining concentrated radionuclides to prepare the waste for disposal onsite. The solid LLW volume would increase at SRS by 13 percent from the No Action volume, requiring 2 acres of additional LLW disposal area per year. There would be no increase in liquid mixed LLW generated by the ALWR. The ALWR solid mixed LLW generation would cause the rate at SRS to increase by 4 percent above No Action, and therefore would have a minor impact. The ALWR would generate a factor of four increase in hazardous waste; additional RCRA-permitted facilities may be required to prepare the waste for

TABLE 4.6.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management Under No Action at Savannah River Site* [Page 1 of 2]

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None (offsite receipts being evaluated) | Stabilization | Under development[a] | Fuel pools and dry storage | Planned[a] | To repository | Not designed |
| **High-level** | | | | | | | |
| Liquid | 5,079 (1,026,000 gal) | Adsorption, evaporation, vitrification | 135,362 (27,343,000 GPY) | Tank farm | 307,714 (62,158,074 gal) | NA | NA |
| Solid | None | None | None | Shielded vault | 5,562 | To repository | NA |
| **Transuranic** | | | | | | | |
| Liquid | None | Grout | Not designed | None | None | NA | NA |
| Solid | 431[b] | Sort, shred | Not designed | Trupact II Containers | Expandable as required | None-WIPP in the future | NA |
| **Low-Level** | | | | | | | |
| Liquid | None | Chemical, filtration, saltstone | 520,158 (105,072,000 GPY) | Ponds, tanks-awaiting processing | NA | NA | NA |
| Solid | 5,100 | Compact | 32,781 $yd^3$/yr | Not stored | Not stored | Burial vaults | 1,400,000 |
| **Mixed Low-Level** | | | | | | | |
| Liquid | 1,336 (275,900 gal) | Chemical, filtration, saltstone | 520,158 (105,072,000 GPY) | Tanks, containers in buildings | 326,380 (65,928,760 gal) | NA | NA |
| Solid | 151 | Incineration, stabilize | Planned | DOT containers (solid), facility | 1,521 | To solid LLW burial onsite | 9,679 |
| **Hazardous** | | | | | | | |
| Liquid | Included in solid | Incineration, stabilize | Planned | Planned RCRA facility | Planned | NA | NA |
| Solid | 13 | Incineration, stabilize | Planned | Planned RCRA facility | Planned | Onsite RCRA facility | Planned |

TABLE 4.6.3.10–1.—*Projected Spent Nuclear Fuel and Waste Management Under No Action at Savannah River Site* [Page 2 of 2]

| Category | Annual Generation Rate ($yd^3$) | Treatment Method | Treatment Capacity ($yd^3$/yr) | Storage Method | Storage Capacity ($yd^3$) | Disposal Method | Disposal Capacity ($yd^3$) |
|---|---|---|---|---|---|---|---|
| **Nonhazardous (Sanitary)** | | | | | | | |
| Liquid | 920,000 (186,000,000 gal) | Filter, strip, settle | 1,900,000 $yd^3$/day (383,000,000 GPY) | Flowing ponds | NA | NPDES discharge | Planned |
| Solid | 80,000 | Incinerate, compact | Expandable as required | None | None | Onsite lined pit | Planned |
| **Nonhazardous (Other)** | | | | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | 6,800 | NA | NA | NA | NA | Recycled | |

[a] Treatment and storage are being evaluated in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS.*

[b] Retrieval and packaging, not new waste.

Note: NA - not applicable.

Source: SR DOE 1993b; SRS 1993a:3.

shipment to a RCRA-permitted disposal facility. Liquid sanitary wastes generated by the Small ALWR would require new treatment facilities since the volume is 16 times the projected No Action volume to be treated in the SRS centralized facilities. The solid sanitary wastes generated by the Small ALWR would increase the generation at SRS by 5 percent more than No Action. This would reduce the life of the landfill or require its expansion.

*Accelerator Production of Tritium.* The APT does not generate spent nuclear fuel. Any liquid LLW generated can be solidified at the point of generation. Solid LLW generation would increase at SRS by 11 percent from No Action, requiring 1 acre per year of additional LLW disposal area. There would be no increase in mixed liquid LLW by the APT. Solid mixed LLW would increase by 5 percent and may require some expansion of planned treatment facilities. Hazardous waste generation would increase 19 percent over No Action, requiring possible expansion or new RCRA-permitted staging facilities. The liquid sanitary wastes generated would be three times the No Action volume and would require additional treatment facilities. The volume of solid sanitary wastes is less than 2 percent of that generated under No Action; and would have a negligible impact to the design life of the existing landfill.

*Less Than Baseline Operations.* In the event of a reduced tritium requirement, the waste volumes shown in table 4.6.3.10–2 would not appreciably change as a result of the HWR operating at less power and the MHTGR and ALWR irradiating fewer target rods. In the case of a Phased APT using the helium-3 target, the waste volumes are approximately the same as the Full APT using the helium-3 target.

**Tritium Recycling Upgrade.** As described in appendix section A.2.2.2, the unconsolidated tritium recycling upgrade at SRS involves only structural upgrades and other modifications that would have no affect on the operational waste volumes from the recycling mission; thus, there are no waste management impacts for the unconsolidated upgrade. A consolidated upgrade is described in the potential mitigation section.

**Tritium Recycling Phaseout.** The phasing out of tritium recycling facilities would decrease the generation of solid low-level, mixed low-level, hazardous, and sanitary wastes. The 7-percent decrease in solid LLW generation would extend the planned life of the onsite LLW disposal facility. The less than 1-percent decrease in mixed LLW generation would have negligible impact. An 8-percent decrease in hazardous waste generation would decrease the number of offsite hazardous waste shipments. The 17-percent decrease in liquid nonhazardous sanitary waste and 10-percent decrease in solid nonhazardous sanitary waste would occur over time as the facilities are transitioned to EM.

**Potential Mitigation Measures.** Each tritium supply technology and the upgraded recycling facilities would be designed to process its own waste into forms suitable for storage or disposal and would use proven waste minimization and pollution prevention technologies to the extent possible. A consolidated recycling facility upgrade could further reduce and minimize waste management. The consolidated upgrade is described in appendix section A.2.2.2 and includes the transferring of functions from Building 232-H. This would result in a 400 $yd^3$ per year decrease in the generation of solid sanitary waste. All other waste volumes would be unchanged. Some facility designs would produce waste quantities or waste forms that could undergo additional reductions by utilizing emerging technologies, thereby further reducing or mitigating impacts. Pollution prevention and waste minimization would be considered in determining the final design of any facility constructed as part of the proposed action at SRS. Pollution prevention and waste minimization would also be evaluated as part of site-specific analyses and tiered NEPA documents.

Utilization of existing treatment, storage and disposal facilities could further reduce impacts. For example, the liquid LLW processing facilities at SRS have capacity exceeding the generation rates of any of the technology options and may be able to process those wastes. The saltstone process in the defense waste processing facility could be utilized for these wastes. Similarly, the Consolidated Incineration Facility is scheduled to complete its mission of treating existing LLW, mixed LLW and hazardous wastes by the time the new tritium supply facility would be constructed. It therefore could be utilized to process LLW, mixed LLW and hazardous wastes from the tritium supply facility. The use of existing incineration at SRS could reduce the volume of solid LLW to be disposed by a

**TABLE 4.6.3.10–2.—*Estimated Annual Generated Spent Nuclear Fuel and Waste Volumes for Tritium Supply Technologies and Recycling at Savannah River Site***

| Category | No Action[a] ($yd^3$) | Tritium Supply Technologies and Recycling Upgrade: HWR ($yd^3$) | MHTGR ($yd^3$) | ALWR ($yd^3$) Large | ALWR ($yd^3$) Small | APT[b] ($yd^3$) | Tritium Recycling Upgrade[c] ($yd^3$) | Tritium Recycling Phaseout ($yd^3$) |
|---|---|---|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | 7 | 80 | 30 | 15 | None | None | None |
| **Low-level** | | | | | | | | |
| Liquid | None | 10,400 (2,100,000gal) | 2,600 (525,000gal) | 24,800 (5,000,000gal) | 3,910 (790,000gal) | None | None | None |
| Solid | 5,100 | 10,300 | 6,400 | 5,810 | 5,760 | 5,640 | 5,100 | 4,750 |
| **Mixed Low-Level** | | | | | | | | |
| Liquid | 1,370 (276,000gal) | 1,370 (276,000gal) | 1,370 (276,000gal) | 1,370 (276,000gal) | 1,370 (276,000gal) | 1,370 (276,000gal) | 1,370 (276,000gal) | 1,370 (276,000gal) |
| Solid | 151 | 271 | 152 | 157 | 157 | 158 | 151 | 149 |
| **Hazardous** | | | | | | | | |
| Liquid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid |
| Solid | 13 | 53 | 113 | 48 | 48 | 16 | 13 | 12 |
| **Nonhazardous (Sanitary)** | | | | | | | | |
| Liquid | 920,000 (186,000,000gal) | 12,500,000 (2,530,000,000gal) | 8,990,000 (1,820,000,000gal) | 32,100,000 (6,480,000,000gal) | 15,000,000 (3,040,000,000gal) | 2,910,000 (587,000,000gal) | 920,000 (186,000,000gal) | 767,000 (154,000,000gal) |
| Solid | 80,000 | 87,600 | 87,400 | 86,900 | 84,200 | 81,200 | 80,000 | 72,200 |
| **Nonhazardous (Other)** | | | | | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | 6,800[d] | 13,300[d] | 13,200[d] | 12,600[d] | 10,300[d] | 6,800[d] | 6,800[d] | Included in sanitary |

[a] The No Action waste volumes are from table 4.6.3.10–1. Waste volumes for tritium technologies were derived by adding the waste volumes of the various technologies found in appendix section A.2 (tables A.2.1.1–4, A.2.1.2–4, A.2.1.3–4, A.2.1.3–5, A.2.1.4–3, and A.2.2.2–4) to the phaseout volumes. The phaseout volumes are derived by subtracting the Recycling Upgrade unconsolidated waste volumes in table A.2.2.2–4 from No Action. Waste volumes have been rounded to three significant figures.

[b] The APT and Recycling waste volumes are based on the spallation-induced lithium conversion target. The helium-3 target volumes are approximately the same with the exception of solid LLW which is 5,170 $yd^3$.

[c] The Tritium Recycling waste volumes are based on the unconsolidated upgrade as presented in appendix section A.2.2.2.

[d] Recyclable wastes.

**TABLE 4.6.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 1 of 2]**

| | Tritium Supply Technologies and Recycling | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | | Tritium Recycling Upgrade | | Tritium Recycling Phaseout | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Spent Nuclear Fuel** | New[b] | New storage facility | New[b] | New storage facility | New[b] | New storage facility | New[b] | New storage facility | None | None | None | None | None | None |
| **Low-Level** | | | | | | | | | | | | | | |
| Liquid | New[c] | New treatment facility | New[c] | New treatment facility | New[c] | New treatment facility | New[c] | New treatment facility | None | None | None | None | None | None |
| Solid | +102 | 12 acres/yr of additional LLW disposal area | +25 | 3 acres/yr of additional LLW disposal area | +14 | 3.5 acres/yr of additional LLW disposal area | +13 | 2 acres/yr of additional LLW disposal area | +11 | 1 acre/year of additional LLW disposal area | None | None | -7 | Extend LLW disposal facility life |
| **Mixed Low-Level** | | | | | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None | None | None | -<1 | None |
| Solid | +79 | Additional facilities | <1 | None | +4 | Expansions of treatment capacity | +4 | Expansions of treatment capacity | +5 | Expansions of treatment capacity | None | None | -1 | None |
| **Hazardous** | | | | | | | | | | | | | | |
| Liquid | Included in solid | | Included in solid | | Included in solid | | Included in solid | | Included in solid | | Included in solid | | Included in solid | |
| Solid | +308 | Additional storage facilities | +769 | Additional storage facilities | +269 | Additional storage facilities | +269 | Additional storage facilities | +19 | Expand storage facilities | None | None | -8 | None |

**TABLE 4.6.3.10–3.—*Potential Spent Nuclear Fuel and Waste Management Impacts from Tritium Supply Technologies and Recycling at Savannah River Site* [Page 2 of 2]**

| | Tritium Supply Technologies and Recycling | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HWR | | MHTGR | | ALWR/Large | | ALWR/Small | | APT | | Tritium Recycling Upgrade | | Tritium Recycling Phaseout | |
| Category | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact | Change from No Action[a] (percent) | Impact |
| **Nonhazardous (Sanitary)** | | | | | | | | | | | | | | |
| Liquid | +1,260 | Additional treatment facilities | +877 | Additional treatment facilities | +3,380 | Additional treatment facilities | +1,530 | Additional treatment facilities | +216 | Additional treatment facilities | None | None | -17 | None |
| Solid | +10 | Reduce landfill life or expansion required | +9 | Reduce landfill life or expansion required | +9 | Reduce landfill life or expansion required | +5 | Reduce landfill life or expansion required | +2 | Negligible | None | None | -10 | Extend life of landfill |
| **Nonhazardous (Other)** | | | | | | | | | | | | | | |
| Liquid | None | None | None | None | None | None | None | None | None | None | None | None | None | None |
| Solid | +96 | None-Project wastes are recyclable | +94 | None-Project wastes are recyclable | +85 | None-Project wastes are recyclable | +51 | None-Project wastes are recyclable | None | None - Project waste are recyclable | None | None - Project wastes are recyclable | Included in sanitary | Included in sanitary |

[a] Reflects a percentage change in generation rate over No Action. Percentage change was calculated using waste volumes prior to rounding. Do not use rounded numbers in Table 4.6.3.10–2 to calculate percentage change.

[b] Although No Action shows no generation of spent fuel, it has been generated in the past, and receipt of fuel from offsite may continue.

[c] No Action shows no generation, but there is in-process treatment of liquid LLW.

Source: Tables 4.6.3.10–1; 4.6.3.10–2.

factor of up to 20. The new central sanitary waste treatment plant could also be utilized. Utilization of these facilities would require site-specific engineering studies and NEPA analysis.

## 4.7 INTERSITE TRANSPORT OF TRITIUM SUPPLY AND RECYCLING MATERIALS

This PEIS examines alternatives to accomplish the future mission for tritium supply and recycling: to retain and upgrade the existing tritium recycling facility at SRS or to locate one of the new tritium supply technologies with or without recycling facilities at one of five candidate sites. All of these would require transporting quantities of hazardous materials, including tritium, between sites. All hazardous materials, except tritium, would be transported by commercial carrier in compliance with DOT regulations. Tritium would be transported by authorized government means. Under all alternatives, tritium reserves would remain in place at SRS; therefore, there would be no impacts for relocating tritium inventory. Transportation impacts could result from normal operation of the tritium supply and the recycling facility. With the tritium supply and recycling facility, there are two kinds of DOE tritium shipments for normal operation: those between DOE facilities and those between a DOE facility and a military first destination.

DOE has extensively studied the risk of accidental dispersal of radioactive materials, including tritium transported by Ross Aviation, Inc., DOE's air cargo contractor. The assessment showed that the probability of an accident by Ross Aviation was $2.7 \times 10^{-4}$ per year. The annual tritium release probability was $1.0 \times 10^{-5}$ and the consequences from the accidental release of tritium is estimated to be $9.0 \times 10^{-8}$ latent cancer fatalities per year.

### 4.7.1 Affected Environment

Although DOE has experienced traffic accidents related to the intersite transport of Complex materials, historically there has never been a traffic accident involving the release of radioactive materials. Therefore, risk impacts were determined using standard analysis criteria and universally accepted computer models.

The Complex's hazardous material (radioactive and nonradioactive) transport requirements are minor compared to the large shipment volume from non-DOE hazardous material transport activities. DOT estimates that approximately 4 billion tons of regulated hazardous materials are transported each year and that approximately 500,000 movements of materials occur each day (PL 101-615, Section 2(1)). There are approximately 2 million annual shipments of radioactive materials involving about 2.8 million packages. This is about 2 percent of the Nation's annual hazardous materials shipments. Most radioactive shipments involve small or intermediate quantities of material in relatively small packages. During 1991, the most recent year for which complete data are available, the Complex shipped about 6,200 radioactive packages (commercial and classified) between its sites. This represents less than 0.3 percent of all radioactive shipments in the United States and about 2 percent of all Complex intersite shipments.

The Complex's unclassified radioactive and other hazardous materials are transported by commercial vehicles (truck, rail, and air carriers). Special nuclear material and radioactive weapons components, representing approximately 3 percent of DOE's total hazardous materials shipments, are transported by DOE's safe secure trailers and the Ross Aviation, Inc., air contract carrier. Typically, these special nuclear materials and weapon components require continual surveillance and accountability by DOE's Transportation Safeguards Division at Albuquerque.

Tritium shipments between sites are made almost exclusively by air by Ross Aviation, Inc. A small number of shipments is made by DOE-owned and -operated safe secure trailers. The safe secure trailers are vehicles designed specifically for the safety and security of the cargo. Shipments by safe secure trailers are accompanied by armed guards and are monitored by a tracking system. Regulatory authority is discussed further in appendix G.

For the analysis of intersite shipments of tritium, the baseline used is the number of limited-life components (tritium reservoir) needed per year to meet all stockpile requirements, including limited-life components needed for replacement in existing weapons. This baseline represents DOE's anticipated tritium workload. The historical and projected data for tritium shipments are classified information.

#### 4.7.1.1 *Site Transportation Interfaces for Hazardous Materials*

The existing transportation modes that serve each of the five candidate sites and the links to those modes for the intersite transport of hazardous materials are summarized in table 4.7.1.1–1.

In *A Report by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel* (October 1991), four sites (INEL, ORR, Pantex, and SRS) were given a comparative rating based on the strengths and weaknesses of their transportation services. For consistency, the rating methodology and evaluation procedures established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel were also applied to NTS. A more detailed discussion of transportation issues is included in appendix G.

#### 4.7.1.2 *Packaging*

Packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packagings used by DOE for hazardous materials shipments are either certified to meet specific performance requirements or built to specifications described in the DOT hazardous materials regulations (49 CFR). For relatively harmless radioactive materials, DOT Specification Type A packagings are used. These packagings are designed to retain their contents under normal transportation conditions. More sensitive radioactive materials shipments, including limited-life components (tritium reservoirs), require the use of highly sophisticated Type B packaging, designed to prevent the release of contents under all credible transportation accident conditions.

Tritium, a low-energy beta emitter, is shielded in its packaging to prevent radiation of detectable levels outside the packaging. Tritium is shipped in packaging specifically designed for containment in an accident. Thus, during normal operations, tritium-related transportation poses no significant risk to transportation workers or the public.

#### 4.7.1.3 *Reactor Vessel Transport*

The reactor vessel is the largest component shipped to a site for installation. The vessel size and weight will vary, depending on the reactor technology and manufacturer selected. Based upon past experience, it is possible to transport a reactor vessel to any of the candidate sites. Transport of this type of equipment would require specific routing, special transport vehicles, and assurance that the transportation infrastructure, from origin to destination, is compatible to accept the size and weight of the load. Barge is a preferred mode of transport, when available. Transport of the reactor vessel is typically the vendor's responsibility. Any potential impacts for reactor vessel transport would be included in site-specific tiered NEPA documentation.

**TABLE 4.7.1.1–1.—*Site Transportation Interfaces***

| Site | Railroad Service (Onsite) | Nearest Inter-State Highway (Miles) | Distance to Airport for Cargo Shipments (Miles) | Barge Service | Possible Weather Delays[a] | Overall Level of Transport Service |
|---|---|---|---|---|---|---|
| INEL | Yes | 46 | 40 | No | Yes | Good |
| NTS | No | 60 | 65[b] | No | No | Good |
| ORR | Yes | 4 | 31 | Yes | Minimal | Good |
| Pantex | Yes | 7 | 20 | No | Minimal | Outstanding |
| SRS | Yes | 30 | 20 | Yes | Minimal | Good |

[a] DOE Transportation Safeguards System shipments.
[b] A closer onsite or nearby airfield could be used for DOE Transportation Safeguards System air cargo shipments only.
Source: DOE 1991j; NTS 1992a:3.

### 4.7.2 Environmental Impacts

Transportation-related impacts result from the movement of materials between sites. The analysis of transportation impacts focused on the movement of tritium because of its greater potential for impacts. The transportation impact assessment on tritium is presented in a qualitative manner because of a lack of historical accident data.

Because there will be no relocation of existing tritium inventory, regardless of the tritium supply technology selected, the only type of transportation impact that could result from alternatives analyzed in this PEIS are yearly impacts associated with the transport of limited-life components during normal operations. Yearly operational transportation impacts could occur regardless of the site selected for tritium supply and recycling. However, if the tritium supply and recycling functions are collocated with the assembly and disassembly function at Pantex, transportation risk would be reduced between DOE sites.

#### 4.7.2.1 *No Action*

Under No Action, tritium functions would remain at SRS. There would be no new tritium supply and no one-time tritium relocation impacts. The only impacts for No Action would be from minimum operational activity. Hence, tritium-related transportation impacts would decrease under No Action, as the tritium inventory was reduced through component replacement or decay.

Under No Action, DOE would have the capability to perform stockpile surveillance activities and to disassemble weapons. These activities would necessitate some transportation of tritium. For both stockpile surveillance and weapons disassembly activities, the weapons would be dismantled at Pantex and tritium components shipped to SRS. The amount of tritium to be transported under stockpile surveillance activities is determined by quality assurance factors (i.e., random selection of weapons for testing and type and number of weapons). Tritium components from stockpile surveillance activities would be shipped at a low level of activity, based upon specific requirements of the stockpile. The annual number of nuclear weapons being dismantled would decrease as goals of the current disarmament treaties are reached. By 2005, weapons disassembly under No Action would be performed primarily to meet weapons inventory replacement needs and is expected to involve approximately 5 percent of the stockpile annually.

The No Action impacts for the transportation of tritium can be summarized as follows:

- Normal (Incident-Free) Operation—For normal operation, the risk of transporting limited-life components to/from SRS is negligible because there are no detectable levels of radiation outside the package.

- Accident Condition—The estimated consequences of transporting limited-life components to/from SRS and Pantex is $9.0 \times 10^{-8}$ latent cancer fatalities per year.

Without a new source of tritium, DOE is projected to eventually run out of tritium reserves. Transportation risks would decrease thereafter until the tritium inventory was depleted.

#### 4.7.2.2 *Tritium Supply and Recycling Alternatives*

With each of the tritium supply technologies and recycling facilities, the only risk would be from transporting limited-life components between Complex sites in the course of normal operations. The impacts from transporting limited-life components would vary depending on where the tritium supply technologies and recycling facilities are located in relation to Pantex or military first destinations. Factors affecting impacts include air mileage, exposed populations, ground support facilities, and road miles travelled to and from airfields.

All possible transportation route combinations were evaluated. Although differences exist, such as air miles traveled, the consequences of an accidental tritium release during transport is estimated to be $9.0 \times 10^{-8}$ latent cancer fatalities per year, regardless of the site selected, because takeoffs and landings will remain the same.

A simplified method of estimating the changes in transportation risk for tritium is to compare with No Action the relative changes in the distance that limited-life components might be transported to or from the assembly/disassembly plant at Pantex.

Using this approach, transportation risk increases or decreases, depending on miles traveled, and can be expressed as a relative mileage factor. The changes in relative transportation risk for the five candidate tritium supply and recycling sites are presented in table 4.7.2.2–1. For a comparison of air mileage distances between sites, see appendix, table G.6–3.

An alternative to collocating tritium supply and new recycling facilities at INEL, NTS, ORR, or Pantex would be to place only tritium supply at these sites and upgrade and continue to use the recycling function at SRS. In this case, the following tritium-related transportation would occur:

- Virgin tritium would be shipped from the tritium supply facility at INEL, NTS, ORR, or Pantex to SRS for processing in the tritium recycling facilities;
- Tritium limited-life components would continue to be shipped from SRS to Pantex for new weapons production;
- Excess tritium limited-life components from disassembled weapons would continue to be shipped from Pantex to SRS for recycling; and
- Tritium limited-life component exchanges would continue to be shipped between SRS and military locations for replenishment.

This option could result in additional impact for transporting virgin tritium from the tritium supply facility to SRS. Two additional trips are estimated per year, or approximately 2 percent of the total distance travelled. Using the relative risk criteria described above, the cumulative risk of this option would vary slightly depending on the location of the selected tritium supply site, but would not exceed a relative risk factor of 1.02. This option poses the highest risk because of the greater distances tritium would be transported.

LLW results from industrial processes and includes radioactively contaminated paper, protective clothing, cleaning materials, metal and glass equipment, tools, and construction items. The Complex's LLW is disposed of at permitted onsite locations with the exception of Pantex, which ships its LLW to NTS. If the tritium supply and recycling facilities were to be located at Pantex, the additional transportation risk of shipping LLW to NTS for normal operation would be negligible, regardless of the reactor technology, for the reasons described in appendix G. Table 4.7.2.2–2 presents the health impacts from transportation accidents due to siting of tritium supply and recycling facilities at Pantex and shipment of LLW to NTS.

The number of fatal cancers per year by radiological release from all credible accidents ranges from a high of $2.99 \times 10^{-8}$ to a low of $3.25 \times 10^{-9}$. For traffic accidents not involving radiological releases, the number of fatalities ranges from a high of $3.96 \times 10^{-4}$ to a low of $4.30 \times 10^{-5}$. Regardless of the tritium supply and recycling alternative, health impacts from transporting additional LLW shipments from Pantex to NTS is small.

Regardless of the tritium supply technology selected, locating the tritium supply and recycling facilities at Pantex would not appreciably increase impacts because of an accident from the transport of LLW to NTS. The impacts of future transport and ultimate disposition of spent nuclear fuel would be addressed by DOE/EM in a separate PEIS.

**TABLE 4.7.2.2–1.—*Comparison of Relative Mileage Risk*[a]**

| Assembly and Disassembly Site | Tritium Supply and Recycling Site | | | | |
|---|---|---|---|---|---|
| | INEL | NTS | ORR | Pantex | SRS |
| Pantex | 0.71 | 0.70 | 0.87 | 0[b] | 1.0 |

[a] The No Action baseline route for tritium is from SRS to Pantex, 1,010 miles. The No Action baseline mileage risk is 1.00.
[b] Zero indicates that the tritium supply and recycling facilities are collocated with the assembly/disassembly function.
Source: DOE 1994b:1.

**TABLE 4.7.2.2–2.—*Impacts from Transporting Low-Level Waste from Pantex Plant to Nevada Test Site***

| | | Accident Impacts (Probability of Cancer or Accident Fatalities) | | | |
|---|---|---|---|---|---|
| | | With a Radiological Release | | Without a Radiological Release | |
| Alternative | Additional Shipments of Low-Level Waste to NTS (per year) | Fatal Cancers from Additional Shipments (per year) | Fatal Cancer Frequency (years) | Traffic Fatalities (per year) | Traffic Fatality Frequency (years) |
| Heavy Water Reactor | 86 | $2.80 \times 10^{-8}$ | $3.57 \times 10^{7}$ | $3.70 \times 10^{-4}$ | 2,703 |
| Heavy Water Reactor and Recycling Facility[a] | 92 | $2.99 \times 10^{-8}$ | $3.34 \times 10^{7}$ | $3.96 \times 10^{-4}$ | 2,525 |
| Modular High Temperature Gas- Cooled Reactor | 22 | $7.15 \times 10^{-9}$ | $1.40 \times 10^{8}$ | $9.46 \times 10^{-5}$ | 10,571 |
| Modular High Temperature Gas- Cooled Reactor and Recycling Facility | 27 | $8.78 \times 10^{-9}$ | $1.14 \times 10^{8}$ | $1.16 \times 10^{-4}$ | 8,621 |
| Large Advanced Light Water Reactor | 26 | $8.45 \times 10^{-9}$ | $1.18 \times 10^{8}$ | $1.12 \times 10^{-4}$ | 8,929 |
| Large Advanced Light Water Reactor and Recycling Facility | 32 | $1.04 \times 10^{-8}$ | $9.62 \times 10^{7}$ | $1.38 \times 10^{-4}$ | 7,246 |
| Small Advanced Light Water Reactor | 13 | $4.22 \times 10^{-9}$ | $2.37 \times 10^{8}$ | $5.59 \times 10^{-5}$ | 17,889 |
| Small Advanced Light Water Reactor and Recycling Facility | 18 | $5.85 \times 10^{-9}$ | $1.71 \times 10^{8}$ | $7.74 \times 10^{-5}$ | 12,920 |
| Accelerator Production of Tritium[b] | 10 | $3.25 \times 10^{-9}$ | $3.08 \times 10^{8}$ | $4.30 \times 10^{-5}$ | 23,256 |
| Accelerator Production of Tritium and Recycling Facility | 16 | $5.20 \times 10^{-9}$ | $1.92 \times 10^{8}$ | $6.88 \times 10^{-5}$ | 14,535 |

[a] High transportation risk alternative.
[b] Low transportation risk alternative.
Source: PX DOE 1993a:1.

The impacts for the transportation of tritium and LLW under tritium supply and recycling alternatives can be summarized as follows:

- Normal (Incident-Free) Operation—For normal operation, the risk of transporting limited-life components is negligible because no detectable levels of radiation outside the package are expected.

- Accident Conditions—The estimated latent cancer fatalities per year from radiological effects due to an accident involving the transport of limited life components is $9.0 \times 10^{-8}$. The worst-case values for transporting LLW between Pantex and NTS are not expected to exceed $2.99 \times 10^{-8}$ fatalities per year from radiological effects and $3.96 \times 10^{-4}$ traffic fatalities per year from traffic accidents not involving radiological releases.

## 4.8 Potential Impacts From Tritium Supply Options

In addition to the impacts described in section 4.2 through 4.8 for the proposed tritium supply technologies and recycling facilities, impacts due to various options are qualitatively described in this section. Where possible, a quantitative analysis is presented. The options identified relate to additional reactor capabilities (electrical production) which have been included in the designs evaluated in this PEIS, an option for providing a dedicated power plant for the APT, and a plutonium mixed oxide fueled reactor.

### 4.8.1 Sale of Steam from Tritium Supply Technologies

Two of the tritium supply reactor technologies, the MHTGR and the ALWR, operate at temperatures high enough to produce electricity by a power conversion facility. Heat transferred to the secondary cooling system could be used to generate steam that would drive turbine generator units. The MHTGR and the ALWR reactor technologies, as described and analyzed in this PEIS, include a power conversion facility. Thus, this PEIS includes the consequences of the production of electricity. Impacts to air, water, land, and human health from energy production are included in section 4.2 through 4.8 for the MHGTR and ALWR; however, distribution and transmission of generated power by the reactors are not assessed. The offsite impacts of the distribution and transmission of electrical power to operate a reactor or an accelerator are also not addressed. Because the conditions associated with the sale of steam for power, or the generation and sale of electricity, are uncertain, it is not possible to assess any specific offsite environmental impacts. However, it is clear that it would be necessary to construct electrical distribution or transmission lines and that electricity would be transmitted across the lines. Thus, the following section discusses the general impacts from the sale of steam or electricity. Similar impacts would also be expected from the construction of transmission and distribution lines to operate the reactor and accelerator technologies. A separate tiered site-specific NEPA review would be required to support a decision to sell steam for power production or to generate electricity.

Because it is not known for any of the sites where or how much new offsite transmission capacity would be required, no specific site impacts can be assessed. However, the general impacts of transmission lines are discussed below.

Construction of an electric distribution or transmission line would result in land use and visual impacts. The level of impact would depend on the existing land uses and the surrounding visual environment. Transmission lines could create strong vertical line and moderate texture contrasts with surrounding landscape, particularly where they run parallel to regional highways. These contrasts would draw attention to the transmission line. Visual impacts may occur along the segments of transmission lines where they cross ridgelines or lands with high visual qualities. The location of towers would likely introduce impacts to the skyline along ridgeline segments and draw strong visual attention from viewers travelling on highways or using regional recreational resources.

Construction of an electric distribution or transmission line would also disturb terrestrial habitats. For example, any crossed wetlands or riparian areas might be disturbed by activities to clear vegetation, place transmission towers, construct maintenance road access, and string cables. With time, disturbed areas in the right-of-ways would undergo some degree of natural succession; however, continued maintenance by the utility would limit the succession stage. The transmission lines could open previously inaccessible areas to human presence through the introduction of roads for construction and maintenance. Workers as well as trespassers using the access roads could increase road kills and general harassment of wildlife in the area of the transmission corridor.

Birds could also be affected by transmission lines. During periods of decreased visibility due to fogging or adverse weather, it is not unusual for birds to collide with lines or transmission towers. The most frequent victims of such collisions are large migratory water birds and raptors in areas where lines are located adjacent to raptor concentration areas, waterfowl wintering staging areas, or other areas with avifauna concentrations. The placement of lines near to where birds congregate (e.g., roosting areas,

lakes, wetlands) could increase the risk and frequency of bird collisions.

Transmission lines produce a corona, which is a physical manifestation of energy loss. This phenomenon results in audible noise, radio and television interference, and the production of ozone in the immediate area of the lines. The effects of corona production decrease dramatically as distance from the line increases.

There is limited scientific understanding of the potential health risks from electromagnetic fields exposure. Electric fields associated with transmission lines are a function of the voltage carried by the conductor and the height above ground. Magnetic fields are a function of the amount of current carried by the line and the height of the conductor. Electromagnetic field exposure typically is attenuated with distance from the conductors. Therefore, electromagnetic field exposure would vary along a transmission line right-of-way. Currently it is not known whether certain magnitudes of electromagnetic field exposure are safer or less safe than other levels. With most chemicals, it is assumed that exposure to higher concentrations is worse than exposures at lower concentrations. This may or may not be true in the case of electromagnetic field exposure. The basic nature of the interaction between electromagnetic field exposure and biological processes is still not understood and, because of this, it is inappropriate to make generalizations about the exposure-response relationships and cancer effects. Also, other health effects have not been studied as extensively as cancer effects, so it is even more uncertain if there are any noncarcinogenic health risks associated with electromagnetic field exposure.

### 4.8.2 Dedicated Power Plant for Accelerator Production of Tritium

As indicated in section 3.4, an option to collocate a dedicated power plant (500 to 600 MWe) at a DOE site or in the site region by a utility to support an APT may be considered a potential but unknown cost saving measure at some sites.

Because it is not known for any of the candidate sites if the power plant option is viable or even reasonable, where such a plant would be located (onsite or offsite), or what type of power plant would be designed, no specific site impacts can be assessed. However, the general impacts that may potentially be expected from construction and operation of such a power plant are discussed below in a qualitative manner. These impacts would be in addition to those described in section 4.8.1 for transmission lines from the regional power pool because the APT would still require this power source as a backup.

Because the fuel source of the power plant (most likely coal or natural gas) is unknown, the following assessment is based on the use of coal, which may potentially have more adverse (e.g., air quality, land use, and water resource) environmental impacts. A brief description of a natural gas electric-generating power plant and general environmental impacts from the construction and operation of a gas fired power plant is also provided for comparison purposes.

#### 4.8.2.1 *Coal-Fired Power Plant*

The design of a 500 to 600 MWe coal-fired, steam-electric generating power plant would vary greatly depending on the site characteristics. However, the major components which could be common to any design can be used to assess general environmental impacts.

The major components of the power plant would include the following: a steam generator (boiler); turbine-generator; air emissions control system (dry scrubber and baghouse); stack; circulating water (cooling water) system; water supply, storage, and treatment facilities; waste management and disposal facilities; and fuel receiving, storage, and handling facilities. In addition to the above components, ancillary facilities for the plant as a whole would typically include access roads, parking areas, a railroad spur, a switchyard, warehouses, and maintenance facilities.

**Construction Activities and Potential Impacts.** Construction activities for the plant site would typically include road access construction and site preparation; construction of plant facilities (fire pumphouse, wells, power lines, an electric substation, etc.); concrete and structural steel erection for main building and support facilities; and construction of a coal receiving and unloading siding. The construction period of a plant of this size is estimated to be approximately 3 years. An estimated average

construction workforce for this period would be approximately 500 persons, with a peak workforce of approximately 800 persons.

Based on power plants of similar size (500 to 600 MWe), approximately 300 acres would be disturbed by construction activities. The area disturbed could increase substantially when ancillary facilities are constructed, such as new railroad spurs. For example, at NTS a new 120-mile-long railroad spur would be required if the plant were collocated with the APT. Land clearing, grading, and general construction activities would impact land use, soils, air quality, and biotic resources at the site. The land use and biotic resources impacts would be long-term. The air quality and soil impacts would be short-term and minor with appropriate standard construction methods. Cultural resources may be potentially affected by clearing, grading, and excavation activities depending on the site. The construction workforce could benefit the revenues of local communities, but could also have adverse impacts on local traffic. Housing and community services in the areas probably would not be affected by a construction project of this size.

**Operation and Potential Impacts.** The power plant is assumed to operate 24 hours a day, 365 days per year, using three 8-hour workshifts. Based on similar sized plants, an estimated operational workforce of approximately 290 persons would be needed. Operation of the plant would typically involve four major activities on a continuous basis: fuel receiving, storage, and handling; power generating system; plant water supply; and plant water treatment.

**Fuel Receiving, Storage, and Handling.** The power plant is assumed to burn coal delivered to the plant site by unit trains. A unit train is defined as a train with 55 coal cars, each with the capacity of 104 tons. Depending on the site, the source of coal could be in another state. Coal would be received from the mine(s) in unit trains that would operate continuously between the mines and the plant. Assuming a 500 to 600-MWe plant operating at a 100-percent capacity factor, approximately 6,000 tons per day of coal would be consumed. Based upon an average annual load factor of 85 percent, the demand would be somewhat lower. Average total annual coal consumption thus would be approximately 1,853,000 tons. To support this average firing rate would require 324 unit trains to be delivered every year.

Once the coal is unloaded it is transferred by conveyor to storage silos that feed boilers or to a coal storage yard. Storage silos for the assumed plant size would typically have a capacity of 12,000 tons and be approximately 70 feet in diameter by 210 feet high. The size of a coal storage yard would typically be based on a 45-day supply at an average annual load of 85 percent of nominal generation capacity. The coal storage yard provides a reserve from which the station can be supplied during coal shortages or emergency situations (e.g., mine strikes, rail strikes).

The potential impacts of fuel receiving, storage, and handling are principally associated with fugitive dust generated by the handling and processing of coal and groundwater quality degradation from the potential releases of constituents leached from coal. However, with current technologies for dust control and coal stockpile management, these potential impacts would be minor.

**Power Generating System.** The power generating system typically includes boilers, turbine-generators, lime spray dry scrubbers, fabric filters, stacks, and mechanical draft cooling towers.

Coal-fired power plants are designed to ensure that coal combustion is complete. Air emissions would include substantial amounts of sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrogen chloride on an annual basis. These products of coal (and to a lesser extent gas) combustion contribute to the regional acid rain problem in the eastern United States, adverse health effects, and potentially the unsolved issue of global warming. Excluding flue gas, the principal products of burned coal would be bottom ash and fly ash carried through to the scrubber and baghouse. An air emission control system designed with best available control technology would minimize air quality impacts and meet applicable state and Federal air quality standards.

A lime spray dry scrubber would require approximately 100 tons per day of lime, and assuming 25-ton capacity pneumatic transfer trailers, 4 additional truck trips per day would be added to site traffic. The air emission control system would also be expected to generate considerable waste products that when

added to bottom ash and mill rejects (pyrites) would generate additional truck traffic and land disposal area impacts. An estimated 22 tons per hour of fly ash and scrubber byproduct and an estimated 3 tons per hour of bottom ash and mill rejects would require disposal in a landfill. Assuming the landfill is permitted and meets regulatory requirements, no impacts, outside of developing the landfill if one does not exist, would be expected. Truck traffic impacts would vary depending on the site and the locations of the landfill (onsite or offsite).

The turbine-generators and associated cooling towers would not be expected to have adverse environmental impacts since no discharges to the environment (except for cooling tower water mist) would occur. In best available control technology designed coal-fired power plants, cooling tower blowdown water is typically used for the scrubber, coal dust suppression, bottom ash transport, and other uses; therefore, minimal discharge or potential impacts to surface waters would be expected.

**Plant Water Supply.** Water, for use in generating steam and for transferring plant-generated waste heat to the atmosphere, would be obtained from either groundwater or surface water depending on the resources available to the site. The estimated water requirement for a 500 to 600 MWe plant is approximately 2.6 BGY. If surface water were used, impacts to land use, soils, and biotic resources and possible wetlands from construction of a pipeline could occur. Operation of the pipeline could also affect the surface water source. Where groundwater was used, new well fields may need to be established along with pumphouses and pipeline. Impacts may potentially occur to groundwater resources (due to drawdown), land use, cultural resources, and biotic resources due to construction of well fields, pipelines, and powerlines.

**Plant Water Treatment.** A number of chemicals would also be expected to be used to treat cooling systems water and boiler feedwater. The use of such chemicals would not have direct environmental impacts in a properly designed plant; however, the storage of these chemicals in large quantities could increase the risk of environmental impacts in accident situations. Typical chemicals for treating cooling system waters include sulfuric acid, lime soda, and chlorine. Boiler feedwater treatment would depend upon the quality of the water available for use at the site. Typical treatment chemicals would include lime, sulfuric acid, caustic soda, hydrazine, and ammonia.

#### 4.8.2.2 *Natural Gas-Fired Power Plant*

A natural gas fueled combustion turbine electric generating power plant design would also vary greatly depending on the site characteristics. Typically, the natural gas combustion turbine facility requires less land, support facilities, water resources, and waste management than coal-fired plants. The following major components would typically be expected in a 500 to 600 MWe generating facility: five or six combustion turbine generator units (approximately 90 MWe rated capacity each); a natural gas supply system; a fuel oil delivery and storage system; a water supply system (wells or surface water); a water demineralization system; and transmission and distribution equipment. In addition to the major components, ancillary facilities for the plant could typically include access roads, parking areas, warehouses, and maintenance facilities.

**Construction Activities and Potential Impacts.** Construction activities would be similar to those described for the coal-fired plant but at a much reduced level. The construction period is estimated be approximately 2 years and the estimated average construction workforce for this period would be approximately 150 persons (approximately 225 peak workforce). Based on similar facilities, approximately 25 acres would be required for this size combustion turbine facility. Ancillary facilities could increase the land requirement and disturbance area substantially. Construction impacts would affect the same resources as those described for the coal power plant but at a substantially reduced level because of the smaller plant size and land disturbance area. Socioeconomic effects would be negligible with this size project.

**Operation and Potential Impacts.** Operation of a natural gas electric generating facility would require a very small workforce compared to a coal power plant. Approximately 50 to 75 workers would be needed. If constructed at an existing utility site, additional workforce requirements could be less since the turbine units could be designed for unattended

operation and remotely operated from the utility dispatch center.

Natural gas, the primary fuel for the combustion turbine, would be directly supplied to the units by pipeline. No additional gas handling or storage facilities would be needed. However, most natural gas combustion plants have the backup capability to burn No. 2 fuel oil in the event of gas supply interruption. This auxiliary fuel would require construction and maintenance of storage facilities. Typically, these are 625,000-gallon above-ground steel tanks approximately 50 feet in diameter and 45 feet in height. Approximately 8 to 10 tanks would be needed for 5 turbine units. To contain accidental spills and prevent potential soil, groundwater, and surface water contamination, a dike system with low permeability floors is typically constructed around the tanks. Fuel oil deliveries to the plant are typically by truck; however, other means such as barge transport may be used depending on the site. Potential impacts to groundwater, surface water resources, air quality, and soils would be minimal with standard industry control measures.

The plant would generate no visible emissions during normal operation; however, the plant could generate and contribute substantial sulfur dioxide, particulate matter, nitrogen oxide, carbon monoxide, and hydrogen chloride emissions on an annual basis. Using a plant design with best available control technology to minimize emissions and comply with applicable air quality standards and permits would minimize impacts to local and regional air quality.

Approximately 590 MGY of water would be needed to operate the plant. A majority of the water requirement (approximately 83 percent) would be for $NO_x$ emission control. Approximately 15 percent of the total water requirement would be used for backwashing deionizer resins and carbon filters used to demineralize the $NO_x$ injection water. The natural gas turbine plant would typically use approximately 23 percent of the water needed for the same size coal power plant. The potential environmental impacts would be anticipated to be similar to those described for the coal power plant; however, the impacts on groundwater and surface water resources may be smaller because of the reduced water requirement.

The demineralized backwash could potentially degrade groundwater and surface water resources if not treated before discharge. Typically, backwash would contain dilute concentrations of trace metals and low to moderate concentrations of calcium, sodium, and sulfate. With appropriate wastewater treatment, no impacts to surface water or groundwater resources would be expected.

### 4.8.3 Multipurpose Reactor

This Tritium Supply and Recycling PEIS evaluates alternative technologies and sites for long-term, assured tritium supply and recycling. Another DOE program office, the Office of Fissile Materials Disposition, is preparing a PEIS addressing the issue of how to dispose of plutonium that is excess to the nuclear weapons complex (see section 1.5.3). Among the alternatives expected to be analyzed in the Storage and Disposition of Weapons-Usable Fissile Materials PEIS is the use of plutonium as a fuel in existing, modified, or new nuclear reactors. Using plutonium in reactor fuel would burn up a portion of the excess plutonium and embed any remaining plutonium in highly radioactive spent fuel, thus reducing the proliferation risks of the material.

The nuclear reactors evaluated for tritium production in this PEIS utilize uranium as the fuel source in their cores, and the analysis is based on that design. Nonetheless, it is conceivable and technically feasible to also use a plutonium or plutonium-uranium oxide (mixed-oxide) fuel for a tritium production reactor. Appendix section A.3 discusses this technical feasibility for each of the tritium supply technologies analyzed in this PEIS. Thus, a tritium production reactor could be utilized by DOE to also dispose of excess plutonium.

Congress and commercial entities have expressed interest in developing a multipurpose reactor that could meet both DOE's tritium supply requirements and dispose of the excess plutonium. A multipurpose reactor is defined as one capable of producing tritium, "burning" plutonium, and generating revenues through the sale of electric power.

Of the four tritium supply technologies evaluated in this PEIS, only the ALWR and MHTGR meet the above definition of a multipurpose reactor. The HWR and APT were not recommended by the Materials Disposition Office Screening Committee for plutonium disposition. Thus, the HWR and APT are not considered for impact analysis in this section.

However, the ALWR and MHTGR can with minor or moderate design changes produce tritium, burn plutonium, and generate revenues through the sale of electric power. This section analyzes the potential environmental impacts if the ALWR or MHTGR were used as a multipurpose reactor. As noted in section 3.2.3, tritium production is the only need addressed in this PEIS. However, if the ALWR or MHTGR were used to produce tritium they could also be used to dispose of plutonium. Therefore, the environmental impacts of a plutonium-burning ALWR and MHTGR are qualitatively presented in this section. These impacts are not analyzed to the same level of detail as those presented for the tritium supply technology alternatives. Furthermore, most of the information required for detailed analysis does not currently exist. Where data does exist, more detailed analysis is presented.

The environmental impacts from tritium and steam production using the MHTGR and ALWR technologies at each of the five candidate sites are described in sections 4.2 through 4.6. The generic impacts from the sale of steam or electricity, including construction of electric transmission lines, are analyzed in section 4.8.1. This section describes the impacts resulting from plutonium burning, the third function that could be performed by a multipurpose reactor.

The ALWR multipurpose reactor would require the construction of a new Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility described in section 4.8.3.1. The reactor changes and potential impacts from using mixed-oxide fuel in an ALWR are discussed in section 4.8.3.2.

For a modular gas-cooled multipurpose reactor, twice as many reactor modules would be needed both to meet tritium requirements and burn plutonium. The additional reactor modules are needed to compensate for the loss in tritium production due to the introduction of plutonium fuel in such a reactor (see appendix A.3.2.2). This is true regardless of whether a 350 MWt MHTGR or a 600 MWt Modular Helium Reactor is used for tritium production (see A.3.1.1 for a description of the helium reactor). Substantial technical uncertainty exists for the use of a gas-cooled reactor for plutonium disposition. In fact, the gas-cooled reactor technology developer believes that it may not be feasible to use the 350 MWt MHTGR design as a multipurpose reactor. The 600 MWt Modular Helium Reactor would be the most likely gas-cooled reactor for multipurpose use.

The environmental impacts associated with tritium production in this PEIS are based upon the 350 MWt

MHTGR and not the 600 MWt Modular Helium Reactor. The design information for a 350 MWt MHTGR represents the best available information for a tritium producing gas-cooled reactor. The impacts of three 350 MWt MHTGR reactors are representative of impacts expected from two 600 MWt modular helium reactors for tritium production (see section A.3.1.1). This correlation is expected to remain true for the environmental impacts of a multipurpose reactor. Thus, the environmental impacts discussed in this section for a gas-cooled multipurpose reactor are based upon the 350 MWt MHTGR design.

In addition to twice as many reactor modules, a new Pit Disassembly/Conversion/Plutonium-Oxide Fuel Fabrication Facility would also be needed for a multipurpose gas-cooled reactor. While such a facility has not been designed it is expected to be similar to the facility described in section 4.8.3.1.

The impacts of the MHTGR plutonium fuel fabrication facility would be minor in comparison to the construction and operation of three more reactor modules. The impacts from construction and operation of three additional MHTGR reactor modules are discussed in section 4.8.3.3.

The discussion of impacts for the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility includes both construction and operation. Impacts are described for a collocated facility with the multipurpose reactor and alone at a separate DOE site. Construction impacts of the ALWR multipurpose reactor would not differ from those described for the tritium production ALWR and therefore are not discussed in this section. Construction of the multipurpose MHTGR would require three additional reactor modules, and therefore construction impacts are discussed.

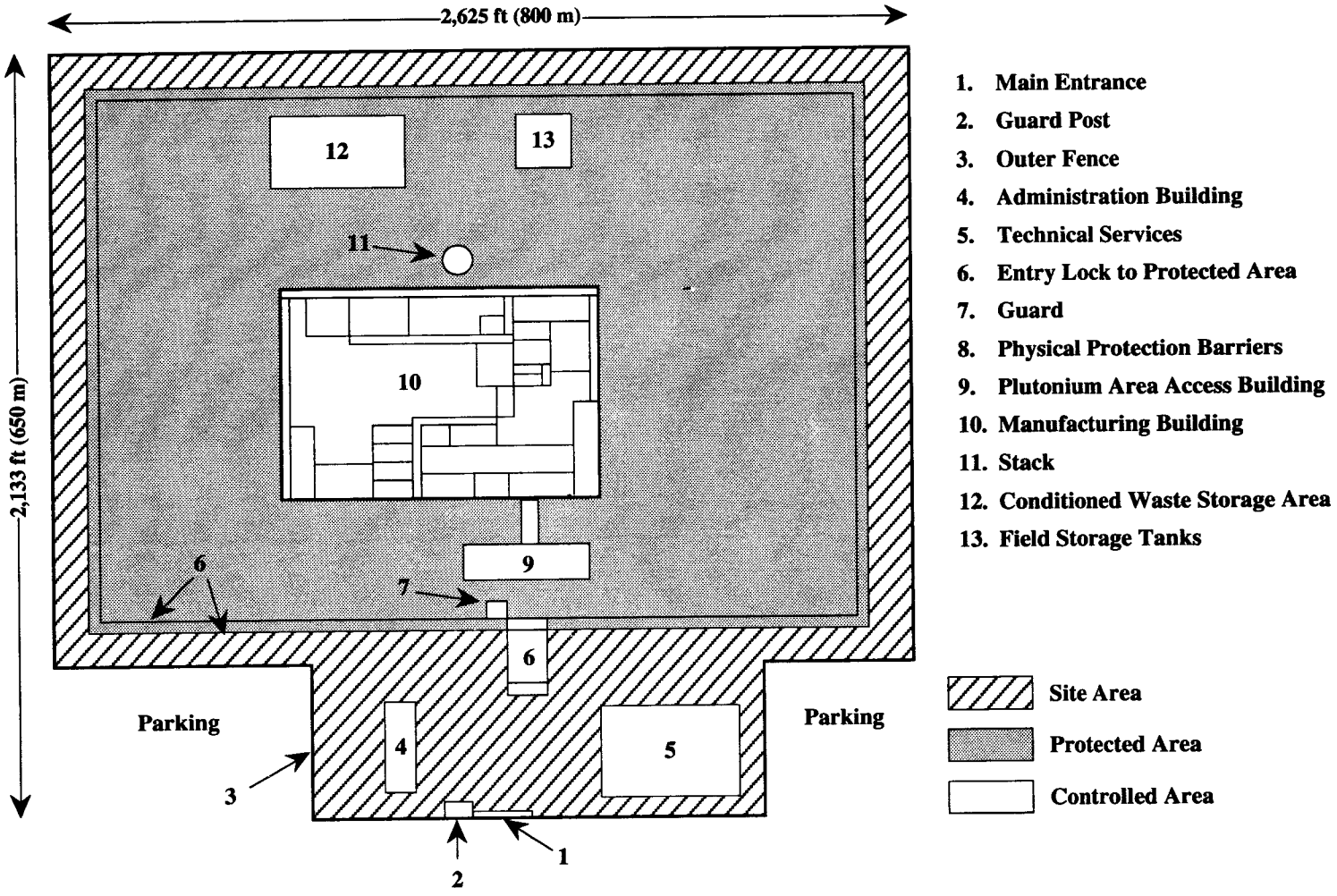
### 4.8.3.1 *Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility*

The primary purpose of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be to combine the functions of pit disassembly, conversion, and mixed-oxide fuel fabrication to produce fuel elements for use in a multipurpose reactor. The facility would accept surplus plutonium in pit form and produce plutonium oxide which would then be combined with uranium oxide received from offsite commercial sources and fabricated into mixed-oxide fuel. This fuel would be assembled into appropriate fuel rods for use in a multipurpose reactor. This process would take plutonium pits, convert them into plutonium oxide, blend with uranium oxide, and form into fuel rods. For any plutonium disposition alternative, the pit disassembly/conversion portion of such a facility would be required. For a multipurpose reactor the fuel fabrication portion would also be required.

**Facility Description.** A new Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be housed in four buildings: (1) the manufacturing building; (2) the plutonium area access building; (3) the administration building; and (4) the technical services building. Figure 4.8.3.1–1 presents the facility plot plan and figure 4.8.3.1–2 presents the manufacturing building layout plan. The manufacturing building would be a hardened facility designed to contain the release of radioactive materials should such a release occur. The plutonium area access, administrative, and technical services buildings would not contain radioactive material production or storage facilities. Table 4.8.3.1–1 presents select key design parameters for the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility. Construction, operation, and waste generation data for the facility are presented in tables 4.8.3.1–2, 4.8.3.1–3, and 4.8.3.1–4.

**Construction Impacts.** The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be constructed in conjunction with either a multipurpose ALWR or MHTGR and could be collocated with the reactor or be sited at another DOE site. The stand-alone option would require the transport of the finished fuel rods to the multipurpose reactor site. The discussion of potential impacts associated with the facility are addressed in relation to a tritium production ALWR or MHTGR and generally are addressed on a non site-specific basis. Areas addressed include land resources, air emissions, and socioeconomics.

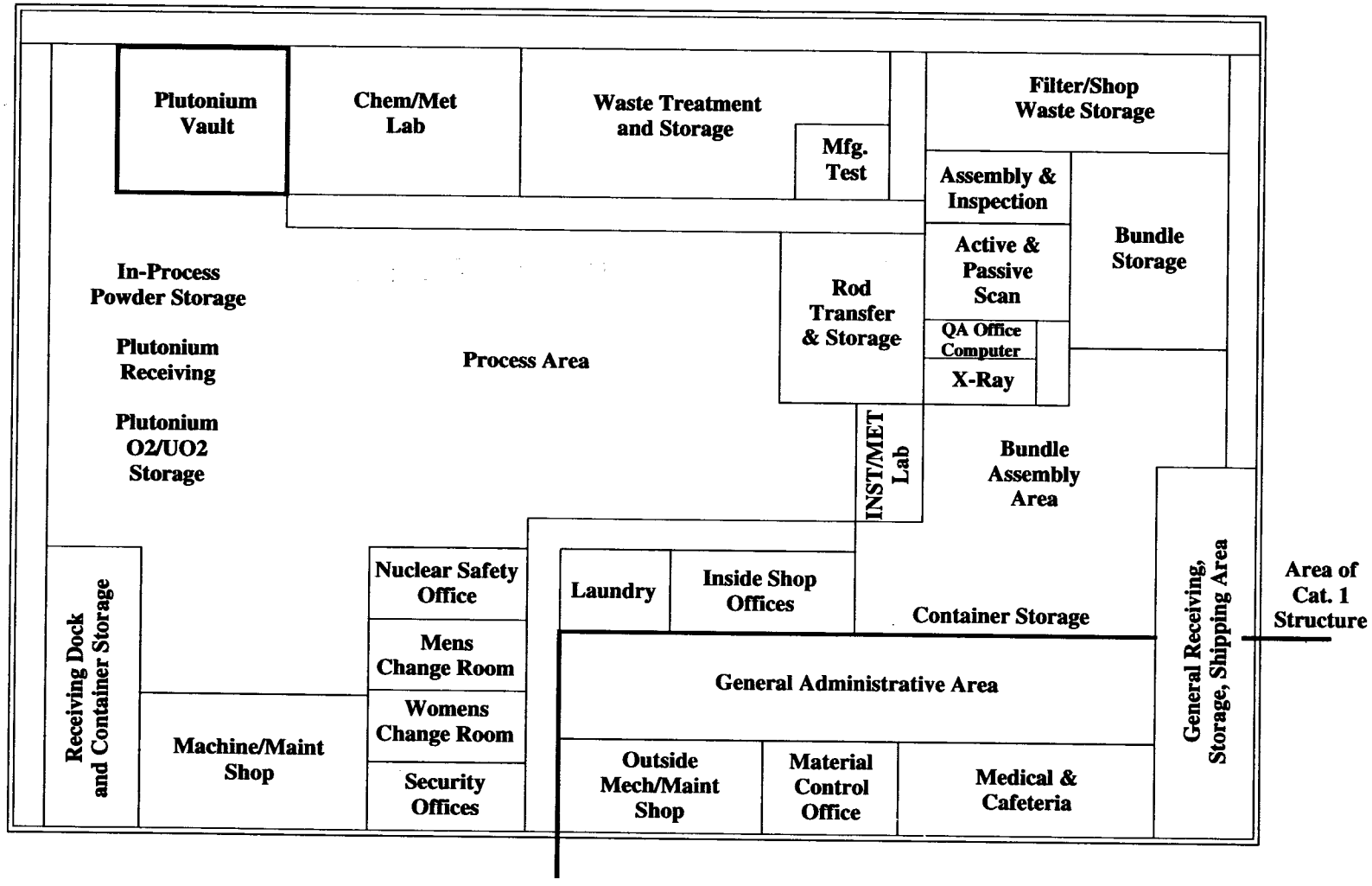
*Land Resources.* The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would require approximately 129 acres of land for a




Source: LANL 1995.a.

2359/TSR

**FIGURE 4.8.3.1–1**—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Plot Plan.*




Source: LANL 1995a.

2360/TSR

FIGURE 4.8.3.1–2—*Manufacturing Building Layout Plan.*

**TABLE 4.8.3.1–1.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Key Design Parameters***

| Design Parameters | Values |
|---|---|
| Primary fuel to boilers and other miscellaneous energy users | Natural gas |
| Buffer zone between operations and site boundary | 1 mile |
| Storage capacity for mixed LLW | 3 year capacity |
| Source of raw water (dry site) | Underground wells |
| Manufacturing building footprint | 115,000 sq. ft |
| Total manufacturing building ventilation rage | 75,000 cfm |
| Manufacturing building HEPA filters (minimum) | 3 stages |
| Mixed-oxide fabrication capacity (metric tones per year) | 100 |
| Public exposure to radiation at site boundary (mrem effective dose equivalent per year) | 100 |
| Worker maximum exposure to radiation (mrem effective dose equivalent per year | |
| Maximum allowable | 1000 |
| Goal | 500 |

Source: LANL 1995a.

**TABLE 4.8.3.1–2.—*Pit Disassembly/Conversion Mixed Oxide Fuel Fabrication Facility Construction Requirements***

| Requirement | Consumption |
|---|---|
| **Material/Resources** | |
| Electrical energy (MW peak) | 1 |
| Concrete ($yd^3$) | 40,000 |
| Steel (tons) | 4,000 |
| Fuel (gal) | 200,000 |
| Industrial gases | 550,000 |
| Water (gal) | 3,000,000 |
| Water (GPD peak) | 5,000 |
| **Land disturbance (acres)** | 129 |
| **Employment** | |
| Total employment (worker years) | 3,155 |
| Peak employment (workers) | 745 |
| Construction period (years) | 6 |

Source: LANL 1995a.

**TABLE 4.8.3.1–3.—*Pit Disassembly/Conversion Mixed Oxide Fuel Fabrication Facility Operation Requirements***

| Requirement | Consumption |
|---|---|
| **Utility** | |
| Electrical energy (MWh per year) | 20,000 |
| Electrical energy (MW peak) | 4 |
| Water (gal/yr) | <10,000,000 |
| Natural gas (scf) | 125,000,000 |
| Diesel Fuel (gal per year) | 8,000 |
| **Plant footprint** | |
| Plant (acres) | 129 |
| **Employment** | |
| Total employment | 650 |

Source: LANL 1995a.

stand-alone facility. For a collocated facility, the land requirement would be less because some of the land developed for the reactor complex would be shared. This additional acreage would not result in a large increase in the percentage of the total land area disturbed by construction at a tritium production site. The loss of an additional 129 acres for a stand-alone facility could lead to increased soil erosion, impacts to biotic resources, and disturbance to cultural and paleontological resources.

*Air Emissions.* Air pollutants generated during construction of the facility would principally be fugitive dust associated with land disturbance and exhaust emissions from equipment and vehicles. These pollutants would represent an incremental increase in those generated during construction of a tritium production ALWR or MHTGR, and would increase the potential for the 24-hour ambient standard for $PM_{10}$ and TSP to be exceeded during the peak construction period. Construction emissions would be expected to be approximately one-half that of constructing a

**TABLE 4.8.3.1–4.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Waste Volumes***

| Category | Annual Average Volume Generated During Construction ($yd^3$) | Annual Volume Effluent During Operation ($yd^3$) |
|---|---|---|
| **High-Level** | | |
| Liquid | None | None |
| Solid | None | None |
| **Transuranic** | | |
| Liquid | None | None |
| Solid | None | 392 |
| **Low-Level** | | |
| Liquid | None | None |
| Solid | None | 524 |
| **Mixed TRU** | | |
| Liquid | None | None |
| Solid | None | 6.5 |
| **Mixed Low-Level** | | |
| Liquid | None | 1 (200 gal) |
| Solid | None | 13 |
| **Hazardous** | | |
| Liquid | None | 1 (200 gal) |
| Solid | None | 13 |
| **Nonhazardous (sanitary)** | | |
| Liquid | <16,500 (<3,330,000 gal) | 495 (10,000,000 gal) |
| Solid | < 674 | 3,920 |
| **Nonhazardous (other)** | | |
| Liquid | None | Included in sanitary |
| Solid | Included in sanitary | Included in sanitary |

Source: LANL 1995a.

tritium recycling facility. Impacts could be reduced by the implementation of mitigation measures such as using water sprays on gravel roads, applying soil stabilizers to inactive construction areas, suspending excavation and grading operations when wind speeds warrant, paving heavily used construction roads, and using electricity from power poles rather than gasoline and diesel power generators.

*Water.* Construction water demand would be approximately 0.5 MGY, with a peak demand of about 5,000 GPD. This would represent a less than 1 percent increase of the total construction demand for either an ALWR or MHTGR tritium production facility. The increase would not be expected to impact either groundwater or surface water supplies if the facility were sited alone at another location.

Sources of waste water during construction include storm water runoff and nonhazardous and/or sanitary discharge. For a stand-alone facility, storm water runoff would result from disturbance of additional land. A collocated facility would potentially disturb less acreage since it would be within the tritium supply complex perimeter. Standard erosion and sediment control measures would minimize adverse impacts from this source. Discharges of nonhazardous and/or sanitary waste water would meet NPDES permit requirements. The combined discharge would not be expected to result in a substantial increase in the flow of receiving water courses.

*Socioeconomics.* Construction of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would require about 550 workers over a 6-year construction period. This would be an approximate 3 to 16 percent increase in the work force needed to build either an ALWR or MHTGR tritium production facility. The number of peak construction workers would be somewhat less if collocated with a tritium production facility. The increase would have some additional impact on local traffic and economies, including increased secondary employment, decreased unemployment, and increased demand for housing and other services.

**Operation.** The discussion of potential impacts resulting from facility operations include atmospheric and liquid emissions, water requirements, socioeconomics, human health during normal operation and accidents, waste, and intersite transportation.

*Atmospheric Emissions.* Operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would generate criteria and toxic/hazardous

pollutants regulated by Federal and state ambient air quality standards and guidelines. Engineering controls or mitigations would be used to minimize air quality impacts from operation with respect to the concentrations of criteria and toxic/hazardous air pollutants, and achieve compliance with all applicable Federal, state, and local air quality regulations or guidelines. Air pollutant emission sources associated with the operation of the facility include power generators, heating boilers, vehicle exhaust and fugitive dust, and other facility emissions. Criteria pollutant emissions are expected to be approximately one-half those expected from a tritium recycling facility. The only likely facility emissions of concern may potentially include trace amounts of volatile organic compounds, hydrogen cleaning solvents, and plutonium oxide (15 μCi per year, which is equivalent to one-millionth of a pound per year).

Prevention of Significant Deterioration regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Prevention of Significant Deterioration permits may be required for the facility if constructed at a separate site from the multipurpose reactor. This may require reductions of existing emissions for the facility to receive permits.

*Liquid Emissions.* Operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would generate approximately 10 million gallons of sanitary waste water per year. This waste water would not have radioactive or hazardous constituents. Sanitary effluents would be treated and discharged in accordance with NPDES permit requirements. Waste water would be sampled and analyzed for radioactive materials, tritium, and heavy metals to determine permit compliance. Storm water would be collected and treated, if necessary, before discharge.

*Water Requirements.* Operation of the facility would require approximately 10 million gallons of water per year, which is approximately 10 percent of the water requirements of a large ALWR at a dry site. This water would be withdrawn from existing surface water and groundwater sources. The increase in water requirements may only cause an impact at Pantex.

*Socioeconomics.* Operation of the Pit Disassembly/Conversion/ Mixed-Oxide Fuel Fabrication Facility would require an additional 650 workers including management and operating contractor, support, and DOE employees. This workforce would represent an approximate 70- to 130-percent increase in operation workers compared to that required for an ALWR or MHTGR tritium supply facility. However, this increase may be somewhat less if the facility were collocated because of shared support facilities and personnel. Additional indirect impacts may also be felt. The in-migrating population could increase the demand for housing units. Revenues of local governments could increase along with expenditures due to an increased burden on community infrastructure.

*Human Health.* The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility design would comply with all applicable Federal, state, and local laws and regulations. Additional industry consensus codes and standards would be applied to the design as appropriate.

*Normal Operation.* As low as reasonably achievable radiological exposure principles would be incorporated appropriately throughout the design of the facility. Worker exposure to radiation would not exceed an annual dose of 1,000 mrem effective dose equivalent. The goal for facility workers is 500 mrem effective dose equivalent per year. Based on historical records at DOE fuel fabrication facilities from 1989 to 1992, a conservative estimated dose of 50 mrem per year would be expected. If all 650 workers were exposed to such a dose, a highly conservative assumption, 32.5 person-rem per year and 0.52 latent cancer fatality (less than one) would be expected over the 40 year operation life of the facility.

The facility design would ensure worker exposure to toxic agents would not exceed 80 percent of the regulatory standard. Any potential use of carcinogens would be minimized or eliminated.

Public exposure to radiation at the site boundary from routine operations would not exceed 100 mrem per year per DOE Order 5400.5, *Radiological Protection of the Public and Environment*, and the *Radiological Control Manual*. The goal for the facility for public radiation exposure would be not to exceed 1.0 mrem

effective dose equivalent per year. The facilities would be designed so that radiation exposure to the public would be as low as reasonably achievable.

*Accidents*. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be designed to comply with all applicable Federal, state, and local laws, DOE orders, and industrial codes and standards. This would provide a plant that is highly resistant to the effects of severe natural phenomena, including earthquake, flood, tornado, high wind, as well as credible events appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity.

The facility would be designed and operated to reduce accumulation of plutonium-bearing scrap, plutonium feed stock processed components, and contaminated wastes during manufacturing operations. This would reduce the potential for an accident and the material available for dispersal during accident scenarios.

Safety analysis reports have not been prepared for the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility. However, for analysis purposes selected bounding accident scenarios have been identified from safety analysis reports and Defense Production safety surveys for similar plants of the existing Complex.

Low to Moderate Consequence Accidents. Several operational and design basis accidents have been identified as reasonably foreseeable for this facility. These accidents include: criticality; explosions and fire; and leaks and spills. The criticality event is the most severe design basis case. Table 4.8.3.1–5 presents a listing of the postulated accidents and the operational and design features of the facility to reduce the likelihood of the accident occurring and/or to reduce the accident consequences. The following discussion identifies potential releases from potential accident events, however, site-specific analysis performed during preparation of safety analysis reports for a new facility would address the impacts from these releases. Any postulated releases to the environment would increase the risk and number of latent cancers to the surrounding population.

Criticality. Operating history has shown that a criticality accident involving violations of procedure would have to occur to result in a criticality event at the facility. A criticality event over the lifetime of the facility is extremely unlikely. A most reasonably foreseeable scenario would assume that there is no barrier between the operator and the criticality event and the criticality would not exceed $5x10^{17}$ total fissions. Fatalities to 50 percent of the workers within 16 feet of such an event could result. Under normal operation conditions it is assumed no more than 4 workers would be this close to the event. Based on this assumption, 2 fatalities would be expected. The possibility of inhalation of gaseous by-products such as iodine, krypton, and xenon would also exist. At a distance of 400 feet from the release point, the thyroid dose from iodine would be 4.6 rem, and from krypton and xenon would be 0.36 rem and 0.70 rem, respectively. Compared to doses resulting from direct exposure to such a criticality event, these doses are inconsequential and well below DOE standards for extreme accidents given in DOE Order 6430.1A.

Explosions and Fire. Safety assessments of the Los Alamos Plutonium Facility and the Rocky Flats Processing and Manufacturing Facility have indicated that a typical bounding explosion is an oxyacetylene explosion next to a glovebox containing plutonium. The initial source term of plutonium released to the room could be 80 grams with an estimated 0.5 curies released from the building (LANL 1995a:41).

A typical severe accident fire is a fire on an open loading dock caused by welding, cleaning solvents, electrical shorts, or other miscellaneous causes. A single drum of combustible waste is assumed to be involved in the fire. The material at risk is 10 grams of plutonium. In the unlikely event that this accident occurred, the source term released to the environment would be $3.4x10^{-4}$ curies (LANL 1995a:41).

Leaks and Spills. The most catastrophic case of leak or spill of nuclear material would result from a fork lift or other large vehicle running over a package of nuclear material and breaching the containment. It is assumed that the package contains 4 kilograms of plutonium oxide. In the unlikely event that this accident occurred, 284 μCi would become airborne in the room. Assuming a three-stage HEPA filtration of the facility exhaust, the total release to the environment would be $1.2x10^{-3}$ μCi (LANL 1995a:42).

**TABLE 4.8.3.1–5.—*Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility Postulated Operational and Design Basis Accidents***

| Description | Facility Operational and Design Features |
|---|---|
| Criticality Accident | There will not be sufficient quantities of plutonium bearing scrap in the facility to cause a criticality accident. |
| | The most likely cause of a criticality incident involving plutonium metals or oxides would be from improper and accidental stacking of items. Multiple violations of procedure would have to occur to result in a criticality event. |
| | The facility design will mitigate the effects of a criticality accident to the general public and workers in adjacent facilities. |
| Explosions and Fire | With the exception of Class C explosives, (e.g., squibs and ammunition for firearms), explosives would not be permitted in the plutonium processing areas of the facility. |
| | The fire protection features for the plant would be in accordance with DOE orders and the National Fire Protection Association Fire Codes and Standards. |
| | One train of fire water supply would meet design basis earthquake requirements. |
| | Automatic sprinkler systems located in the plutonium processing areas would be safety class. |
| | Smoke detectors would be installed throughout the facility. |
| | A fire hazards analysis would be performed to assess the risk for a fire within the individual fire areas of the facility. |
| | The manufacturing building would be designed with passive fire rated barriers to withstand the maximum possible fire and contain the fire within the given compartment in the event of failure of all fire detection and suppression systems. |
| Leaks and Spills | Confinement and containment of nuclear material would be provided for the manufacturing building by the building structure and the ventilation system. This confinement system would include the entire external structure and the ventilation system. |
| | The manufacturing building would be designed and constructed to withstand the forces of a design basis earthquake without significant cracking. |
| | Multiple barriers would be used to limit release of plutonium from the facility manufacturing building. |
| | The facility would exhaust process air through a minimum of three HEPA liters, with the first filter usually located on the glovebox. |

Source: LANL 1995a.

Low Probability/High Consequence Accidents. The consequences/risks from beyond design basis accidents have also been considered for the facility. The postulated bounding accident postulated for the facility is a large airplane, such as a Boeing 747, fully loaded with fuel, crashing through the roof of the manufacturing building. If such an accident occurred, several kilograms of plutonium could be released to the environment. Analyses of nuclear criticality events caused by airplane crashes are limited; however, it has been estimated that the neutron yields and consequences would be similar to the criticality incident described for the low to moderate consequence accident (LANL 1995a:43).

Accident Mitigation. The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility design would meet the appropriate level of public health and safety goals. DOE has adopted two quantitative safety goals to limit the risks of fatalities associated with its nuclear operations. These goals are:

- The risk to an average individual in the vicinity of a DOE nuclear facility for immediate fatalities that might result from an accident should not exceed 0.1 percent of the sum of immediate fatalities resulting from other accidents to which members of the affected population are generally exposed. For evaluation purposes, individuals are assumed to be located within 1 mile of the site boundary.

- The risk to the general population in the area of a DOE nuclear facility for latent cancer fatalities that might result from normal operations should not exceed 0.1 percent of the sum of all cancer fatality risks resulting from all other causes. For evaluation purposes, individuals are assumed to be located within 10 miles of the site boundary (LANL 1995a:41).

*Waste Management.* Construction and operation of the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would impact existing waste management operations at a site by increasing the generation of TRU, mixed TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes. Table 4.8.3.1–4 lists the projected waste volumes generated from construction and the waste effluent volumes from operations. If the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility was collocated with the multipurpose reactor, these waste volumes would be added to those in table 3.4.2.2–3 (MHTGR) or 3.4.2.3–3 (Large ALWR). If the multipurpose reactor and the tritium recycling facility are collocated at any site other than SRS, the waste volumes in table 3.4.3.1–3 (New Tritium Recycling Facility) would also have to be added. Wastes from the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be treated and packaged into forms that would enable long-term storage and/or disposal in accordance with the *Atomic Energy Act*, RCRA, and other relevant statutes as outlined in chapter 5 and in appendix section H.1.2.

Waste generated during construction would consist of wastewater and nonhazardous solid wastes. The nonhazardous wastes would be disposed of as part of the construction project by the contractor. For operations, the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would be the only generator of TRU and mixed TRU waste. Such wastes would result primarily from plutonium processing operations and are expected to be "contact-handled" TRU waste. Solvents, lead, and scintillation vials would comprise the hazardous constituent of mixed TRU wastes. TRU and mixed TRU wastes would be treated and packaged according to the Waste Isolation Pilot Plant waste acceptance criteria. These wastes would be stored at the Pit Disassembly/Conversion/Mixed Oxide Fuel Fabrication Facility or an existing site facility, if available, until WIPP is determined to be a suitable disposal facility pursuant to the requirements of 40 CFR 191 and 40 CFR 268, or another suitable repository is found. Assuming 11.4 $yd^3$ per truck shipment, 22.8 $yd^3$ per regular train shipment, or 68.6 $yd^3$ per dedicated train shipment, approximately 35 truck, 18 regular train, or 6 dedicated train shipments per year of TRU waste would be required. TRU waste management options would be determined by decisions resulting from the Waste Management PEIS now being prepared by DOE.

The liquid LLW generated by the Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would use the multipurpose reactor treatment facilities if collocated. If not collocated and depending on the site, a liquid radioactive waste treatment facility may need to be constructed. The concentrated radionuclides would be solidified and disposed of in an approved LLW disposal facility. Other solid LLW such as contaminated clothing, shoes, wipes, and HEPA filters would be compacted as appropriate and disposed of in an approved LLW disposal facility. Liquid and solid mixed LLW would be stabilized and staged in a RCRA-permitted storage facility until treatment could be accomplished in accordance with the site treatment plan that was developed pursuant to the *Federal Facility Compliance Act.* Liquid and solid hazardous wastes would be stabilized and compacted if appropriate, and packaged in DOT-approved containers for transport to RCRA-permitted treatment and disposal facilities using DOT-certified transporters. Depending on the site, additional hazardous waste accumulation facilities may be required if not collocated with the multipurpose reactor. Liquid and solid sanitary wastes would be managed in accordance with current site practices. Additional liquid sanitary and industrial wastewater treatment facilities may be

required if not collocated with the multipurpose reactor.

*Intersite Transportation.* The Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility would receive pits and send out completed fuel assembly bundles and associated waste products. The destination of the completed fuel assembly bundles and associated waste products would depend on the location of the multipurpose reactor and the final disposition option selected for plutonium. Transportation of pits, completed fuel assembly bundles, and associated waste products would be subject to government regulations and DOE orders. Transportation issues include criticality control, shielding, and containment of nuclear material. The composition and form of the radioactive materials to be transported would determine the applicable portions of the regulations as well as the packaging design.

The risks associated with the transport of radioactive material by various transport modes have been assessed in a number of NEPA related documents such as: the *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes,* NUREG-0170; the *Final Environmental Impact Statement, Special Isotope Separation Project,* DOE/EIS-0136, 1988; the *Environmental Assessment of the Risks of the Taiwan Research Reactor Spent Fuel Project,* DOE/EA-0515, 1991; and the *Environmental and Other Evaluations of Alternatives for Siting, Constructing, and Operating New Production Reactor Capacity,* DOE/NP-0014, September 1992. Based on the analyses in these documents, it can be concluded that the transportation risks are very small even for large quantities of special nuclear materials, including plutonium pits, by safe-secure trailers over extended time periods. In NUREG-0170, the U.S. Nuclear Regulatory Commission (NRC) concluded that "the risks attendant to accidents involving radioactive material shipments are sufficiently small to allow continued shipments by all modes." Therefore, the potential public health risks and environmental consequences resulting from normal transportation and postulated severe accidents are expected to be low.

#### 4.8.3.2 *Mixed-Oxide Fueled Advanced Light Water Reactors*

The ALWR tritium-producing reactor technology previously described in section 3.4 and appendix A.2.1.3 offers the possibility of transforming excess weapons plutonium into spent nuclear fuel within a few decades. This section discusses this concept for the ALWR technology. Commercial light water reactors operating in the United States are similar to the ALWR described in this PEIS and also can perform this plutonium consumption function. The NRC has already evaluated mixed-oxide burning light water reactors in the *Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed-Oxide Fuel in Light Water Cooled Reactors* August 1976 (NUREG-0002), and presented extensive information on the changes and impacts in the overall fuel and plant that may occur. This document was used as the basis for analyzing the impacts of the tritium production ALWR, analyzed in this PEIS, when operating as a mixed-oxide fueled multipurpose reactor.

For the purpose of plutonium consumption, excess weapons plutonium could be mixed with natural or depleted uranium to produce a mixed-oxide fuel that could be used in typical commercial light water reactors. The tritium production ALWR cores are similar to the commercial light water reactors. Current designs and analyses support using mixed-oxide fuel in the core without major modifications. The tritium production ALWR reactors are described in section 3.4.2.3 and appendix A.2.1.3. This section describes the potential impacts of using the tritium production ALWR with a mixed-oxide fueled core derived from weapons surplus plutonium.

**Construction Impacts.** Construction impacts associated with a multipurpose ALWR would not be different from those expected from the tritium production ALWR. Impacts from construction and operating the new Pit Disassembly/Conversion/Mixed-Oxide Fuel Fabrication Facility necessary to support the multipurpose ALWR are addressed in section 4.8.3.1.

**Operation.** For operation impact analysis, changes in the operating characteristics of the tritium production ALWR were compared with the analysis presented in the *Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed-Oxide Fuel in Light Water Cooled Reactors.* The identified changes for operating baseline and potential impacts are addressed for the following categories: emissions; personnel; radiological and human health (normal operations and accidents); waste; and spent fuel. The other resource issues would not be expected to change from those described for the tritium production ALWR and are not analyzed further in this section.

*Emissions.* The NRC report indicated that chemical discharges released to the air and to water bodies do not change for the mixed-oxide fueled light water reactor. Similar findings are anticipated for the ALWR (NRC 1976a). The NRC report also indicated that there is an increase of tritium in the radioactive gaseous and liquid effluent releases when light water reactor fuel is changed from uranium oxide fuel to mixed-oxide fuel. Comparison of comparable reactor systems using different fuels shows that in no case are emissions significantly altered by changes in fuel types. Therefore, emissions from normal operations are expected to be changed very slightly by the introduction of mixed-oxide fuel into reactor systems originally fueled with uranium oxide (NRC 1976a). Table 4.8.3.2–1 presents a summary of the findings.

**TABLE 4.8.3.2–1.—*Increase of Radioactive Materials for the Mixed-Oxide Fueled Light Water Reactor***

| Release of Radioactive Materials | Percent Increase Over Uranium Fueled Reactor[a] |
|---|---|
| **Radioactive materials released in liquid effluents:** | |
| All releases except tritium | 0 |
| Tritium only | 8.3 to 9.3 |
| **Radioactive materials released in gaseous effluents:** | |
| All releases except tritium | -2.8 to 0 |
| Tritium only | 9.1 to 9.3 |

[a] Releases would vary depending upon the type of light water reactor.

Source: NRC 1976a.

*Personnel Requirements.* The use of mixed-oxide fuel in the ALWR will cause an increase in personnel requirements for unloading and receipt inspection of the fuel assemblies; safeguards and security of the nonirradiated fuel assemblies on the reactor site; wet and dry storage of spent nuclear fuel; unloading, inspection, and storage of empty and decontaminated spent nuclear fuel storage casks; handling and packaging of spent fuel for shipment; and loading spent nuclear fuel casks on trucks and/or railroad cars for shipment offsite. The number of personnel cannot be quantified at this time but is not expected to increase substantially. The number of additional workers and related impacts would be addressed in project specific analysis.

*Radiological and Human Health Impacts During Normal Operation and Accidents.* During normal operations of reactors small quantities of fission products and induced activities are released to the environment. The exposure pathways for radiation doses that might be delivered to individuals at locations on and beyond the boundaries of the multipurpose reactor site include liquid effluents, gaseous effluents, and direct radiation. Based on measurements made at operating commercial light water reactors, direct radiation doses are negligible (< 5 mrem per year) and in the case of both boiling water and pressurized light water reactors, the type of fuel would have virtually no effect on direct radiation dose rates (NRC 1976a). The analysis performed by the NRC on commercial light water reactors burning mixed-oxide fuel, which would be expected to be similar for the multipurpose ALWR analyzed here, showed that in no case is dose significantly altered by changes in fuel types. The NRC report concluded that the calculated dose to individuals from normal operations is perturbed very slightly by the introduction of mixed-oxide fuel into reactor systems originally fueled with uranium oxide. The total dose to workers, however would be expected to increase in relation to the number of additional workers at the facility.

Workers handling irradiated mixed-oxide fuel assemblies could potentially be exposed to higher doses since these assemblies would have neutron radiation levels that are about two orders of magnitude higher than the neutron radiation levels for irradiated uranium oxide fuel assemblies (NRC 1976a). To minimize this increased exposure, irradiated

mixed-oxide fuel handling at the multipurpose ALWR site would be performed remotely as is done for uranium fuel.

The consequences of postulated accidents for light water reactors utilizing mixed-oxide fuel was also analyzed in the NRC report. Based on the analysis, the assessment of the environmental impact of postulated accidents from mixed-oxide cores was that it was not significantly different from the environmental impact from currently used uranium oxide cores (NRC 1976a). Although the fission yields of some isotopes vary slightly for the mixed oxide core, the conclusion drawn would not be any different for a multipurpose ALWR.

*Waste.* Since waste generation is not a function of reactor fuel type, no increases in waste generation rates or characteristics are expected due to the change from uranium oxide reactor fuel to mixed-oxide reactor fuel.

*Spent Nuclear Fuel.* The NRC report indicated that decay heat in spent mixed-oxide fuel assemblies could be 10 to 20 percent greater than decay heat in spent uranium oxide fuel assemblies. Higher decay heat loads may require changes to reactor operational procedures. The reactor power level may have to be derated and/or the reactor Emergency Core Cooling System performance requirements may have to be upgraded based on the safety analysis results for the mixed-oxide-fueled reactor. The increased decay heat load in the mixed-oxide fuel assemblies could also impact the following: (1) extend refueling outage reactor cooldown time and (2) reduce the fuel assembly storage density in the fuel pool and dry storage casks or increase fuel pool cooling requirements and increase the fuel pool dwell time prior to dry storage.

*Transportation/Handling.* The use of mixed-oxide fuel would have a significant impact on transportation and handling of the spent nuclear fuel. The handling of the spent nuclear fuel would most likely require remote operations (GA 1994a). Due to the higher radiation levels of the spent mixed-oxide fuel, the weight of the shipping casks would increase because of the additional shielding. Due to the higher decay heat of the spent fuel, fewer spent fuel assemblies could be loaded into each shipping cask (NRC 1976a). Thus handling (i.e., packaging), loading, unloading, and transportation requirements would be increased for spent mixed-oxide fuel.

#### 4.8.3.3 *Plutonium-Oxide Fueled Modular High Temperature Gas-Cooled Reactor*

A plutonium fueled MHTGR, unlike the ALWR, would result in a decrease in tritium production efficiency. The decrease in tritium production is due to the design which restricts the tritium target placement to only core reflectors. In order to meet the steady state tritium requirement, six 350 MWt reactor modules would be needed (see appendix A.3.2.2). Therefore, the predominant environmental impact of burning plutonium in MHTGRs would be the construction of three additional reactor modules. The in-core changes of individual reactors would be minor contributors to environmental impacts of a multipurpose MHTGR compared to the construction of three additional modules.

Unlike the light water reactor, which has had significant environmental analysis prepared for using mixed-oxide fuel, no detailed environmental studies have been prepared for an MHTGR. Nonetheless, many of the principals in the *Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed-Oxide Fuel in Light Water Cooled Reactor* would apply. Therefore, the impacts discussed in this section are directed to the construction and operation of three additional MHTGR 350 MWt reactor modules. The Pit Disassembly/Conversion/Plutonium Fuel Fabrication Facility needed to support the MHTGR, although conceptually slightly different than the Mixed-Oxide Fuel Fabrication Facility described in section 4.8.3.1, would be expected to have similar impacts.

**Construction Impacts.** Adding three additional 350 MWt reactor modules would increase construction resource requirements by approximately two as shown in table 4.8.3.3–1. The construction period would also be somewhat longer, approximately 3 to 4 years, to accommodate the three new reactor module construction. The resource and issues areas most affected by the expanded module construction would be land resources, water resources, geology and soils, and paleontological resources.

*Land Resources.* The addition of 3 reactor modules would require more land. Assuming economics of scale and shared support infrastructure,

**TABLE 4.8.3.3–1.— *Multipurpose Modular High Temperature Gas-Cooled Reactor Estimated Construction Material/Resource Requirements***

| Material/Resources | Six Reactors Consumption |
|---|---|
| Electrical energy (MWh) | 131,400 |
| Concrete ($yd^3$) | 396,000 |
| Steel (tons) | 108,000 |
| Fuel (gal) | 5,760,000 |
| Water (gal) | 288,000,000 |

approximately 240 additional acres would be needed. The larger land siting requirements may pose a problem at sites with limited available land. If the multipurpose MHTGR and plutonium fuel fabrication facility were collocated with a new tritium recycling facility, land requirements could approach approximately 1,000 acres. Impacts to current and proposed site land use plans and development would need to be addressed in site-specific analysis.

*Water Resources.* The estimated total water requirement needed for construction of a 6 reactor module MHTGR would be approximately 288 million gallons. This represents an average annual water requirement increase of approximately 33 percent over a tritium production MHTGR. At sites where available water supplies were limited or already experiencing adverse water withdrawal impacts, the additional water requirements would cumulatively add to existing adverse impacts. Depending on the site, groundwater dewatering effluent volume and activities might increase due to the additional excavation required for the three added reactor modules. Site-specific analysis would be needed to identify the extent and severity of water resource impacts.

*Geology and Soils.* Adding three additional reactor modules would substantially increase the soil disturbance and excavation requirement at a site. Soil erosion control measures would minimize impacts to surface water and would not be expected to increase the affects expected from the tritium production MHTGR with three reactor modules. The additional excavation required for three more reactor modules would also substantially increase the volume of soil needing storage and/or disposal. Groundwater flow direction may be influenced by the extent of excavation depending on the site. Appropriate engineering measures are available to minimize groundwater infiltration into the excavation.

*Paleontological Resource.* Depending on the site, the increased excavation required for the additional reactors may add to the potential for affecting paleontological resources. Site-specific analysis and studies would be needed to evaluate the extent and severity of potential impacts.

**Operation Impacts.** The changes in the operating baseline of the tritium production MHTGR to accommodate plutonium fuel by adding three additional 350 MWt reactors are addressed for the following resource and issue areas: site infrastructure, water resources, socioeconomics, radiological impacts during normal operation and accidents, and waste management.

*Site Infrastructure.* Modifications to site infrastructure would be required to accommodate a six-reactor multipurpose MHTGR. Additional electrical power and other fuel requirements would increase substantially over the tritium production MHTGR (see table 4.8.3.3–2). Water requirements for the multipurpose MHTGR would increase over the tritium production MHTGR. Additional wells, pumps, pipelines, and water treatment facilities may need to be constructed to support the multipurpose six-reactor MHTGR.

**TABLE 4.8.3.3–2.—*Multipurpose Modular High Temperature Gas-Cooled Reactor Estimated Operation Utility Requirements***

| Utility | Six Reactors Consumption |
|---|---|
| **Electrical Energy (MWh per year)** | |
| Wet site | 468,000 |
| Dry site | 648,000 |
| **Electrical Load (MWe)** | |
| Wet site | 65 |
| Dry site | 83 |
| **Fuel** | |
| Gas ($ft^3$per year) | 10,800,000 |
| Liquid (GPY) | 146,000 |
| **Water (MGY)** | |
| Wet site | 7,200 |
| Dry site | 54 |

*Water Resources.* Depending on the site, surface water and/or groundwater requirements for operations would increase by 80 percent by the addition of three more reactor modules. Water use would be approximately 7,200 MGY at a wet site and 54 MGY at a dry site. Adverse impacts to groundwater and/or surface water resources may occur depending on the site. Where water resources are allotted or are currently being adversely impacted due to existing water use, the additional water requirements for the multipurpose MHTGR would exacerbate the impact. Discharges due to cooling water discharge (at wet sites) or cooling systems blowdown could potentially impact receiving water bodies. Potential impacts, such as stream flow increases, stream bed scouring, and sediment transport, may increase due to the increase in discharge volume. Engineering measures such as plunge or stilling basins, retention basins, or lined conveyance channels to minimize impacts of such discharges may require additional land or new support site infrastructure. Treatment of all wastewater discharges would minimize potential impacts to water quality. Therefore impacts from the additional water discharges would not be substantially different than that expected from the tritium production MHTGR analyzed in this PEIS.

*Socioeconomics.* Construction and operation of a multipurpose MHTGR would require more personnel. Therefore, more direct and indirect socioeconomic affects would occur in the region. Approximately 15,860 worker-years would be needed to construct the six-reactor multipurpose MHTGR, an increase of 7,050 worker-years over the three-reactor tritium production MHTGR. Operation of the multipurpose MHTGR would require 1,640 workers, an increase of 730. The specific effects would need to be determined in site-specific analysis. However, in general the effects would be an increase in housing demand and benefits to local government public finances. An increase in employment and population would also be expected once constructed but impacts would not be substantially different from that expected from a tritium production MHTGR with three reactors. The effects would be influenced by the specific site region and would need to be addressed in a site assessment to determine the magnitude of the impacts.

*Radiological and Human Health Impacts During Normal Operation and Accidents.* Radiological impacts to the public and site workforce resulting from normal operations cannot be determined without source term data for a plutonium fueled multipurpose MHTGR. However, with the addition of three reactor modules total doses to the maximally exposed member of the public, population doses, and the annual dose to the site workforce would increase. Worker doses may potentially double from the those expected from a three-reactor tritium production MHTGR because of the additional three-reactor modules. Site-specific analysis would need to be performed to determine the estimated radiological impacts to these potential receptors. Engineering design measures would be required to be incorporated into any multipurpose MHTGR design to meet applicable standards for the protection of the public and site workers.

The multipurpose MHTGR with six reactor modules would have a potential for accidents that may impact the health and safety of workers and the public. The assumption can be made and supported that with more reactors the potential for accidents to occur may increase as well as the radiological impacts to the public and site workforce. However, due to the lack of source term data and accident behavior for a plutonium fueled multipurpose MHTGR, postulated accidents and resulting radiological impacts to site worker and the public cannot be determined at this time.

*Waste Management.* The operational waste volumes for the six reactor module multipurpose MHTGR would almost double those presented in table 3.4.2.2–3. Depending on the site, additional treatment and storage facilities may be required. Waste management options would be determined by decisions resulting from the Waste Management PEIS now being prepared by DOE. New facilities may potentially have adverse impact on site land use, air quality, biotic resource, and worker health and safety. Those new facilities already identified for the three-reactor module tritium production MHTGR would have to be designed to handle the additional waste volumes associated with a six-reactor module multipurpose MHTGR.

*Spent Nuclear Fuel.* The volume of spent nuclear fuel generated in the six-reactor module multipurpose MHTGR would approximately double the spent nuclear fuel from the three-reactor module tritium

production MHTGR. However, as observed in section 4.8.3.2 for the light water reactor the spent mixed-oxide fuel assemblies would have greater decay heat. Because the increased decay heat reduces storage density in the pool area and increases the fuel pool dwell time prior to dry storage, the spent fuel storage requirement would more than double that required for the three-reactor module tritium production MHTGR. Additional impacts to worker health and safety from the increased spent fuel handling may also occur.

## 4.9 CUMULATIVE IMPACTS

Impacts from the siting, construction, and operation of a new tritium supply and recycling facility would be cumulative with impacts from existing and planned facilities and actions at the five DOE candidate sites. The consequences section for each resource and issue area identifies, as appropriate, the cumulative effect of tritium supply and recycling impacts to impacts from existing and planned operations.

A cumulative impact is defined as the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This section discusses potential impacts from other facilities, operations, and activities that in combination with potential impacts from the Tritium Supply and Recycling Proposal may contribute to cumulative impacts within the 2010 to 2050 time frame.

Implementing the Tritium Supply and Recycling Proposal would contribute to cumulative impacts. Depending on the alternative selected, changes in regional employment, population, housing, local government finances, and local transportation would occur. For the tritium supply alternatives at the DOE candidate sites, construction and operation employment and the cumulative indirect land use impacts associated with housing and employment would be expected to increase. If a tritium supply facility were sited at any site other than SRS and new recycling facilities were constructed at INEL, NTS, ORR, or Pantex, the adverse cumulative socioeconomic impacts resulting from the phaseout of existing tritium recycling facilities at SRS would be negligible (section 4.6.3.8). The phaseout would occur over a number of years and the impacts would be offset by the actions at other DOE sites.

Impacts from reasonably foreseeable near-term projects at DOE candidate sites are included in the No Action baseline (2010) environmental conditions. For each site except SRS, the impacts of No Action include the effects of site activities other than tritium supply and recycling facilities. Information on EM's potential future waste management activities at DOE sites was included as appropriate in the assessment of waste management impacts. Project-related impacts are added to the future baseline predicted for air quality, socioeconomics, human health, and waste management at each site. The sum of the baseline and the predicted impacts represent the cumulative impacts for each of these resource and issue areas. Discussion of these impacts can be found in each of the site environmental consequences sections. Other more long-range impacts associated with the proposed Environmental Management Program and the Storage and Disposition of Weapons-Usable Fissile Materials Program are speculative at this time, but could increase cumulative impacts, depending on the decisions resulting from the PEIS being prepared for these programs and the time frame of site-specific projects. Because of the budget requirements that would be necessary to implement any of the proposed tritium supply alternatives, other major future defense program projects at DOE candidate sites would be unlikely or phased in over an extended period. The potential for programmatic cumulative impacts for the other resources and issues was analyzed but was determined to be negligible.

Because of the preconceptual design and non-site-specific location of the technologies and proposed facilities at candidate DOE sites, cumulative impacts are discussed qualitatively. More detailed cumulative analysis would occur in site-specific tiered NEPA documents resulting from decisions stemming from this PEIS and the ROD.

Because it is not known for any of the sites where or how much new offsite electrical transmission capacity would be required, no site specific cumulative impacts of transmission lines can be assessed. However, the general cumulative impacts of transmission lines are identified in the following appropriate resource and issue area discussions. The same approach is used to address potential cumulative impacts from a dedicated power plant (section 4.8.2) to support the Accelerator Production of Tritium (APT) and Multipurpose Reactor option discussed in section 4.8.3.

Construction and operation of any tritium supply and recycling facility would have a minimal cumulative impact on the available land at candidate sites or the

continued/expanded missions at the sites. Land requirements for tritium supply and recycling facilities would be approximately 3.5 percent or less of the total site area at all sites. Additional onsite cumulative land use impacts at INEL, NTS, and Pantex associated with new rights-of-way for electric transmission power lines are expected. The largest cumulative impact on regional power pools would occur with the APT. Construction of new primary and secondary roads at INEL, NTS, and SRS and additional railroad lines at INEL and SRS would increase land use cumulative impacts of the proposed action at these sites. A decision resulting from the Surplus Fissile Material PEIS to locate a consolidated storage facility at one of the candidate sites would have a minimal cumulative impact on the available land with the largest impact being with the MHTGR at Pantex. The land requirement for a consolidated plutonium and highly-enriched uranium storage facility is approximately one-fourth that required for any tritium supply and recycling facility.

Construction of offsite electrical transmission lines would have cumulative land use, visual, and biotic resource impacts. Where possible these impacts can be minimized by upgrading or constructing new lines parallel to existing lines. Constructing and operating a dedicated power plant for the the APT would require an estimated additional 25 to 300 acres, depending on the type of plant, and have a cumulative impact on site land use, biotic resources, and visual character. Additional acreage would be required for ancillary infrastructure to support such a facility. If the power plant were constructed offsite by a utility adjacent to or within an existing power station complex, the potential cumulative impacts may be reduced.

Environmental restoration activities at INEL, ORR, and SRS are expected to coincide with construction and operation activities of proposed tritium supply and recycling facilities, thereby increasing impacts to air quality from incineration of contaminated soil and hazardous waste. The environmental management activities at these sites are expected to last approximately 30 years while construction and operation of the tritium facilities would continue for a 40-year period. The net impact to air quality at these sites would be an increase in emissions during the periods of concurrent construction followed by operation of the tritium supply and recycling facilities and environmental management activities. In the long term, air quality at all sites is expected to improve as facilities are decommissioned and waste minimization programs are instituted. No exceedance of ambient air quality standards is expected from cumulative impacts.

Operation of a dedicated power plant for the APT or a pit disassembly/conversion/mixed-oxide fuel fabrication facility to support a multipurpose reactor would add cumulatively to the expected criteria pollutant air emissions at a site. Operation of a multipurpose reactor would result in a small increase in radiological air emissions over those expected from the tritium production reactors.

The cumulative impacts of constructing and operating a tritium supply and recycling facility at any of the DOE candidate sites on the regional economies, population, housing, local government finances, and local transportation would be minor. Generally, the regional economies and local government finances would improve without burdening the housing market, but increased traffic would further aggravate congestion on local roads. Future environmental restoration management activities and fissile materials program activities could create additional jobs (both direct and indirect) at potential candidate sites. For example, under the various alternatives being considered for the Spent Nuclear Fuel Management program, maximum employment would reach about 1,700 person-years per year. The Surplus Fissile Material program also has the potential to add employment to the sites under consideration for the Tritium Supply and Recycling Proposal. The cumulative socioeconomic impact of the three programs is not expected to increase significantly because of the relatively small size of each program. The primary impact will be to stimulate regional economic growth. If all of these programs were located at one site, transportation congestion could increase as well as the demand for new housing and other public services. However, these needs could be offset by additional tax revenues generated by new residents.

It should also be noted that if the APT alternative is selected and a dedicated power plant is constructed, additional socioeconomic impacts would result. The size of the construction and operation workforce would depend on the type of fuel used to power the plant. For example, a coal fire plant generating 500

to 600 MWe would require a construction workforce of 500 (peaking at 800) and operation workforce of approximately 290. A natural gas fired plant would require a construction workforce of 150 (peaking at 225) and an operation workforce of 50 to 75. These employment levels should not significantly increase the demand for public services or housing at the candidate sites.

Cumulative human health impacts in the form of additional cancer risk to workers and the public from the environmental management program and fissile materials program activities at INEL, NTS, ORR, and SRS are expected to be minor. The cumulative impacts are attributed to more onsite workers and increased exposure to radioactivity due to remediation activities at the sites. The potential cumulative health impacts from the Spent Nuclear Fuel Management program under the Centralization Alternative at INEL, NTS, ORR, and SRS are expected to minimal. Over a 40-year period, the estimated number of additional fatal cancers resulting from Centralization would range from 0 to about 2. Applicable regulations, standards, and monitoring would pertain to all environmental management program activities. The annual radiation dose to workers and to individual members of the public from the tritium supply and recycling activities would remain constant. However, the collective dose to and numbers of cancers in the population would increase due to the projected increase in the population within 50 miles of the site.

The expected increase in radiological air emissions from a multipurpose reactor would contribute to the cumulative human health impacts at a site. Small increases in site worker doses would also be expected from the pit assembly/emission/mixed-oxide fuel fabrication facility. The cumulative human health impacts to workers and the public are expected to be within applicable regulations and standards.

The cumulative impact on waste management activities that would result from siting new tritium supply and recycling facilities would be affected by future decisions resulting from the *Environmental Management PEIS*, the *Spent Nuclear Fuel Management and INEL Environment Restoration and Waste Management Programs EIS*, and the *Surplus Fissile Materials PEIS*. The largest cumulative impacts from the Environmental Management PEIS for INEL, ORR, Pantex, and SRS would arise if they were selected to be a regional treatment and disposal site for LLW and mixed LLW. The largest impact for NTS would occur if it were selected as a central disposal site for LLW and mixed LLW. If INEL, NTS, ORR, Pantex, or SRS were selected as a result of the ROD from the Environmental Management PEIS, the waste volumes for the proposed tritium supply and recycling facilities would be a less significant contributor to the waste management at these sites.

There would be no cumulative impacts on waste management from the *Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management EIS* for Pantex. The largest cumulative impacts for INEL, NTS, ORR, and SRS would result if one of these sites were selected as a centralized storage site for spent nuclear fuel. Depending on the site selected, additional waste volumes would be generated from stabilization activities over the years 1995 to 2005 and operation of the centralized storage facility.

For the Surplus Fissile Material PEIS INEL, NTS, ORR, Pantex, and SRS have been selected for the possible consolidated storage of plutonium and highly-enriched uranium. Site selection for the Surplus Fissile Material PEIS analysis for the other alternatives such as mixed oxide fuel fabrication have not been completed. Wastes generated from a consolidated storage facility are small; therefore, cumulative impacts on waste management from a consolidated storage facility are minimal when added to the tritium supply and recycling projected impacts.

## 4.10 Commercial Light Water Reactor Contingency

Production of tritium using commercial power reactors is a potential contingency measure to meet the projected tritium requirements for the Nation's nuclear weapons stockpile in the event of a national emergency. The purchase by DOE of an existing operating or partially completed commercial power reactor is also an option to meet the stockpile tritium requirement mission. The reactors employed for domestic electric power generation in the United States are conventional light water reactors, which use ordinary water as moderator and coolant.

Commercial light water reactors use both pressurized water reactor and boiling water reactor technologies. Feasibility studies show that of the two types of reactors, pressurized water reactors are more readily adaptable than boiling water reactors to the requirements of tritium production by DOE tritium target rod irradiation.

### 4.10.1 Potential Impacts

The option to purchase an operating commercial power reactor or finish construction of a nearly complete commercial reactor to support the stockpile tritium requirement would have similar impacts as described in the following discussion. The reactor technologies and characteristics would be the same. However, some additional land use impacts may occur to incorporate security infrastructure and other requirements which would be needed for a DOE owned and operated tritium production facility. The potential land use impacts would result from new buffer zone requirements, new fencing, security buildings, and road access restrictions or construction of new roads. The NEPA documents prepared for the commercial reactors by the NRC would need to be supplemented under the "purchase option" to address the additional impacts expected with conversion to a DOE site dedicated to a tritium production mission.

The following discussion of impacts is based on the pressurized water reactor technology and two production scenario options. The first option is the single reactor scenario in which one reactor would be loaded with sufficient DOE targets to meet weapons stockpile tritium requirements. Under this scenario, some fuel rods may be replaced with DOE target rods. The second option is the multiple reactor scenario in which several reactors (more than 2, but fewer than 10) are used in order to minimize operational impacts. This scenario entails replacement of burnable poison rods (neutron-absorbing rods designed to control reactivity and power distribution in the core) with the appropriate number of DOE tritium target rods, which would have nominally the same effect on core reactivity and core power distribution over the life of the fuel cycle as the burnable poison rods, thus enabling each reactor to maintain its current power production.

**General Description.** Commercial pressurized water reactors are high-temperature, high-pressure reactors that use ordinary light water as the coolant and moderator and are capable of generating large amounts of electricity through a steam turbine generator. The range of electrical production for these plants is approximately 390 million kWh per year to 6,900 million kWh per year using an assumed annual capacity factor of 62 percent. A typical commercial light water reactor facility includes the reactor building, cooling towers, a switchyard for the transmission of generated electricity, maintenance buildings, administrative buildings, and security facilities. Acreage for existing operating commercial light water reactor facilities varies in size from a low of 84 acres to a high of 30,000 acres.

The designs of typical commercial reactors incorporate numerous safety features including: a reactor containment building to limit any release of radioactivity; an emergency core cooling system for heat removal in the event of a loss of coolant or a loss of pumping; an emergency shutdown system with safety rods independent of the reactor control rods; and a backup system to remove heat from the reactor if the primary coolant fails to circulate.

For commercial reactors to be used to produce tritium, the commercial reactor sites would have to obtain new fuel assemblies with the DOE target rods included or target rods to replace burnable poison rods from an offsite source. Additionally, irradiated target rods would have to be shipped offsite to a DOE site for tritium extraction and recycling.

**Operating Baseline.** Characteristics for a generic commercial light water reactor are listed in table 4.10.1–1. Data for each reactor characteristic is empirical and taken from individual site operation reports covering a representative calendar year (1990). Data for 12 operational reactors were used to determine a nominal average for each listed characteristic except shipped LLW and stored mixed waste per 1,000 MWe. The waste values presented are averages for all pressurized water reactors in operation in 1990 and, as such, are more representative of the reactor type as a group. The characteristics listed in table 4.10.1–1 were judged adequate for describing a generic commercial light water reactor.

**TABLE 4.10.1–1.—*Generic Commercial Light Water Reactor Operational Parameters***

| Operational Parameter | Nominal Average Value |
|---|---|
| Thermal rating (MWt) | 3,500 |
| Thermal generation (MWhr) | 21,000,000 |
| Electric rating (MWe) | 1,200 |
| Electric generation (MWhr) | 7,000,000 |
| Unit availability factor (percent) | 76 |
| Water uptake ($ft^3$/sec) | 770 |
| Site size (acres) | 6,000 |
| Estimated population (2010) within 50-mile radius | 2,000,000 |
| Airborne tritium (Ci/yr) | 36 |
| All other gaseous radioactive effluent (Ci/yr) | 0 |
| Liquid tritium (Ci/yr) | 500 |
| All other liquid radioactive effluent (Ci/yr) | 3 |
| Shipped LLW ($ft^3$/yr) | 8,800 |
| Number of shipments per year | 20 |
| Stored mixed/1000 MWe ($ft^3$/yr) | 3,500 |
| Total annual whole body personnel dose (person-rem) | 200 |
| Total refueling personnel annual whole body dose (person-rem) | 20 |
| Assemblies discharged | 170 |
| Licensed spent fuel pool storage capacity (assemblies) | 1,500 |
| Projected date for last refueling discharge to spent nuclear fuel pool storage | 2006 |

Source: FDI 1994i.

A neutron-absorbing material called a burnable poison (typically boron-10) is used in some commercial light water reactor core designs to reduce local power density and even power distribution across the core, thereby extending the life of the fuel. Burnable poison is added to the reactor core design, either in a distributed form mixed with the uranium oxide fuel or as a discrete rod.

The use of commercial light water reactors to irradiate DOE tritium target rods is based on the concept of replacing the boron-10 burnable poison rods with lithium-6 target rods configured to have a similar effect on power density and which, upon neutron interaction, also results in tritium production. While burnup characteristic of lithium-6 target rods may not match exactly, the substitution can be accommodated with little impact on the reactor operations. For the purpose of evaluating commercial light water reactor feasibility, targets are assumed to be of a single uniform design and lithium-6 enrichment. Symmetry to previous core designs has also been assumed. To produce current stockpile tritium requirements, about 6,000 target rods would be needed.

The commercial light water reactor would operate at its currently licensed full power for the generation of electricity while performing a secondary mission of tritium production. The rate of producing tritium is a function of power level, lithium-6 enrichment, time of operation, and target-loading density, and therefore would vary based on the specific reactor and the alternative commercial reactor production scenario option selected.

The following operational characteristics are associated with the single reactor scenario:

- One reactor loaded with sufficient DOE targets to meet current stockpile tritium requirements;
- Some fuel rods may be replaced with target rods which would require fuel disassembly to remove the target rods for tritium extraction;
- Full core refueling required, with a major reduction in attainable fuel burnup;
- Significant increases in spent nuclear fuel storage requirements are included, and may result in requirement for onsite dry storage of spent nuclear fuel;
- No effect expected on ability to attain full power, but the reactor may be limited to baseload operation with restricted rate of load change;
- Changes to plant support systems may be required;
- Target handling tools and fixtures must be added to the complement of spent nuclear

fuel pit equipment, and target packaging and transportation are added to the scope of normal utility activities.

The following operational characteristics are associated with the multiple reactor scenario:

- For analysis purposes, consists of eight reactors deployed to the tritium supply mission;
- Replacement of burnable poison rods with the appropriate number of DOE target rods to yield approximately the same effect on core reactivity and core power distribution over the life of the fuel cycle;
- No effect on core design, refueling cycle durations, or spent fuel storage requirement; however, some tradeoffs involving fuel enrichment and cycle burnup may arise in optimizing the fuel management strategy;
- No effect on normal operation, including plant maneuvering capability or mode change restrictions;
- Few or no changes to plant support systems would be required;
- Target-handling tools and fixtures must be added to the complement of spent fuel pit equipment, and target packaging and transportation are added to the scope of normal utility activities.

In the multiple reactor scenario the number of fuel rods and the performance requirements imposed on the fuel would not be changed. However, to minimize fuel cycle impacts in the multiple reactor scenario, it would be desirable to extend the design life and qualification of the DOE target rod to envelope the longest fuel cycle commonly used in a commercial light water reactor. Qualification for extended use is not a necessary condition to the feasibility of the concept, since the single reactor scenario does not require it.

The single reactor scenario represents the largest number of DOE target rods inserted into a reactor, the highest tritium content, and the largest perturbation to the existing safety analysis of the plant. Insertion of the necessary number of DOE target rods to produce current tritium requirements in a single reactor results in the replacement of approximately 15 percent of the fuel rods in a large reactor with a 17x17 matrix of rods per assembly. It is technically feasible to increase the average heat generation in the remaining fuel rods to compensate for this amount of replacement of fuel rods by DOE target rods without jeopardizing the plant's ability to operate at full-power.

The use of a commercial reactor or multiple reactors for producing tritium would result in additional environmental impacts from the changes in the reactor operational characteristics (table 4.10.1–1) due to the introduction of DOE target rods. Impacts would most likely result from core changes, personnel requirements, effluent, waste, spent fuel, operational variances (radiation exposure), and transportation/handling. Impacts from these seven factors are discussed in general terms based on a "typical" nonsite-specific commercial light water reactor.

**Core Changes.** Production of tritium in a commercial light water reactor would require physical changes to the reactor core, which could range from replacement of burnable poison elements with DOE target elements to the replacement of fuel rods with DOE target assemblies. Core changes could alter the accident basis and would modify the source term. The estimated additional core tritium content in curies per reactor at the end of the irradiation period would be $3.2 \times 10^7$ for a single reactor. Because of the reduced burn up in the reactor core, the total fission products in each fuel rod would decrease. Using multiple reactors to produce the same quantity would reduce the curies of tritium per reactor.

**Personnel Requirements.** The added requirements to execute DOE target handling and shipping activities would be expected to create new job tasks and require that additional personnel be hired at the commercial reactor site. An estimated 75 additional personnel would be needed for a typical commercial nuclear power facility. The additional personnel would represent an increase of approximately 9 percent for a single reactor. The number of personnel

would be smaller for each commercial reactor site if multiple reactors were used. In the case of a single reactor, it is assumed that one work crew would handle 12 DOE tritium target shipments per year, with each shipment containing about 500 target rods. The work crew would include fuel pool workers to remove and package the target tritium rods from the fuel assemblies. Assuming multiple reactors, no manpower increases would be anticipated during refueling. The preparation of the DOE targets for shipment would require a single crew at one work station for each reactor. Shipments would include 500 targets each and would be handled by a single crew covering all reactors. Three crews of fuel pool workers could handle all reactors.

**Effluent.** Because of the addition of DOE target rods, airborne and water-borne effluent would be expected to change (particularly for tritium). Estimates for expected increases of gaseous tritium effluent range from 1,090 Ci per year for a single reactor to 136 Ci per year in the multiple reactor scenario. For a typical commercial plant, these values represent an increase of 3,028 percent and 378 percent, respectively. Compared to total curies of gaseous effluent released, they represent increases of 140 percent and 18 percent, respectively. Estimated increases of liquid tritium effluent ranges from 15,120 Ci per year for a single reactor to 1,890 Ci per year per reactor in the multiple reactor scenario. For a typical commercial plant, these values represent an increase of 3,000 percent and 375 percent, respectively. Compared to total Ci of liquid effluent released, they represent increases of 2,982 percent and 373 percent, respectively. For a single reactor, the release of fission products to the reactor coolant could be expected to significantly decrease because the fission product inventory is lower due to the lower average fuel assembly burn up, and the fuel element failure rate is lower due to the shorter residence time in the core (FDI 1994i). However, there would be a net 5-percent increase in rod surface areas that would come into contact with the coolant. This would proportionately increase the reactor "crud" that accumulates on rod surfaces and could lead to a 5-percent increase in the neutron activation products that enter into the coolant.

**Waste.** Additional activities associated with the handling, processing, and shipping of DOE target assemblies would be expected to increase waste generation rates at the commercial reactor site. An estimated 4,420 $ft^3$ per year of LLW per reactor would be expected. This would be approximately a 50-percent increase for a typical plant. No increase in mixed waste generation would be anticipated. In a multiple reactor scenario where DOE targets would displace burnable poison rod assemblies, the total LLW generation rate would not increase.

**Spent Nuclear Fuel.** More frequent refueling operations and the segmenting of fuel assemblies could result in an increase in spent nuclear fuel volumes. This increase could result in additional requirements for wet and dry storage space at the reactor site. An estimated 137 additional fuel assemblies per year per reactor would result from the production of tritium, an increase of approximately 245 percent for a typical plant. No increase in spent nuclear fuel is expected with the multiple reactor scenario. The change to 12-month refueling cycles with full core discharge would accelerate the consumption of available spent nuclear fuel pool storage and would require earlier use of additional storage alternatives such as dry storage at some commercial reactor sites.

**Operational Variances.** New DOE target assembly process activities and, in some cases, more frequent refueling-type operations would be expected to increase radiation exposure for some categories of workers. Estimates for expected increases of exposure for refueling personnel range from 19 person-rem per reactor for maintenance workers to less than 1 person-rem for supervisory personnel. In the multiple reactor scenario, no additional refueling personnel would be required; therefore, no additional worker exposure would be expected. In addition to refueling operations, three other areas of exposure would be anticipated to be associated with the DOE tritium targets. These areas are waste operations, fuel pool work, and target shipments. The increase in person-rem per reactor for all personnel ranges from 24 for maintenance workers to 1 for supervisory personnel. The more reactors used to produce the tritium, the smaller the increase in person-rem per reactor.

**Transportation/Handling.** In the event commercial reactors are used to produce tritium, irradiated target assemblies would be containerized and transported from commercial reactor sites to SRS for tritium extraction and purification. Some additional risk

would be expected to be incurred due to the transport of these elements. Assuming that an inventory of 500 target rods would be accumulated for shipment at one time in NRC-approved fuel assembly shipping casks, and one cask per transport truck, approximately 12 shipments per year would occur. The curie content per truck would be approximately $2.7 \times 10^6$. No additional loading, unloading, or handling facilities would be required at the commercial reactor site because provision for shipment of spent fuel is already within the design of these facilities.

The estimated probability of accidents occurring during transportation, derived from DOE and DOT empirical data bases, and the upper bound additional exposures (50-year committed effective dose equivalent) that might be experienced as a result of transporting target rods, were used to estimate radiological consequences of a transportation accident. Factors considered in the analysis included historical accident rates; optimum routes via interstate highways; rural, suburban, and urban population densities along the route; and national meteorological atmospheric dispersion parameters incorporated in DOE's RADTRAN transportation risk computer code (FDI 1994i:16). Table 4.10.1–2 shows the upper bound radiological consequences of an accident during transportation from a single site to SRS. The values are based upon 12 shipments of irradiated target assemblies being transported per year and conservatively assumes that in any truck accident 100 percent of the irradiated target assemblies would be released into the environment as tritiated water with no plume drop-out. Such an event might incur an additional 240 person-rem per year. Shipments from geographically diverse locations could incur some smaller average of the values shown.

### 4.10.2 Institutional Issues

A review and assessment of the institutional issues associated with the use of a commercial light water reactor for the production of tritium was performed during the preparation of this PEIS. The study focused on information available in the public record on statutory requirements and government policy, nuclear regulatory and licensing issues, and economic regulation/financial impact issues.

The review indicated that no statutory, regulatory, or treaty requirements have been found that would prohibit the use of commercial nuclear power plants to produce tritium for use in U.S. defense programs. There are, however, policy issues related to the separation of civilian and military uses of nuclear technology that are not fully consistent with use of commercial light water reactors for such purpose. The purchase of a commercial light water reactor by DOE for tritium production could potentially mitigate these policy concerns, but raises certain concerns with regard to the process that would be used to accomplish the transfer of ownership.

**Statutory Requirements and Government Policy.** Although resolutions have been introduced in Congress that would have placed restrictions on the production of tritium in commercial light water reactors for weapons purposes, the statutory review identified no restrictions in law that would preclude such production.

Congressional budget action has been taken to restrict or terminate activities associated with the development of capabilities for tritium production in light water reactors. These actions have generally been initiated in response to a limited budgetary situation and do not indicate basic disagreement with the concept.

**TABLE 4.10.1–2.—*Radiological Consequences of a Transportation Accident Shipping Tritium Target Rods***

| Reactor Site Origin | Total Shipping Distance (Miles) | Radiological Consequences (person-rem per year) | | | |
|---|---|---|---|---|---|
| | | Rural | Suburban | Urban | Total |
| Eastern | 1,110 | 0.08 | 1.03 | 84.30 | 85.3 |
| Midwest | 895 | 0.07 | 0.74 | 95.54 | 96.3 |
| Western | 2,750 | 0.25 | 1.36 | 237.63 | 239.0 |

Source: FDI 1994i.

The nonproliferation policy of the United States is exercised through the *Nuclear Non-Proliferation Act* of 1978 and the Treaty on the Non-Proliferation of Nuclear Weapons. The U.S. has voluntarily included all commercial light water reactor facilities as available for inspection under International Atomic Energy Agency safeguards. Nothing in these instruments would preclude using commercial light water reactor facilities to generate tritium for weapons use.

The U.S. government endorsed the principle of separation of military and civilian uses of nuclear technology in the 1985 and 1990 Non-Proliferation Treaty review conferences. Generation of tritium for weapons use in utility-owned light water reactor facilities could be viewed as blurring the line between military and civilian nuclear technology.

**Nuclear Regulatory and Licensing Issues.** Title 10 Chapter I of the *Code of Federal Regulations* was reviewed to identify rules and regulations with potential impact on implementing tritium production in currently licensed commercial light water reactors. No provisions were found in 10 CFR Chapter I that would preclude the use of commercial light water reactors for production of tritium for weapon use.

Changes would be required in a commercial light water reactor to permit generation of tritium for weapons use. The magnitude of the change will dictate whether a license amendment (in accordance with 10 CFR 50.90) would be required, or if the change could be implemented without an amendment. The changes to the plant associated with the single reactor option would likely require changes to the technical specifications. The multiple reactor option may not require technical specification changes or other changes to the license, particularly if no increase in the maximum authorized enrichment is needed. Nonetheless, prior review by the NRC of the use of a commercial light water reactor for tritium production can be expected.

Regulatory clarifications may be necessary concerning the option of DOE purchasing an operating reactor. The NRC is currently without the authority to transfer the operating license to DOE. Therefore, it would appear necessary to terminate the license. No process, however, was identified for specifically terminating an NRC operating license under 10 CFR 50 for a facility that will continue to operate. Regulations that govern license termination require decommissioning of the facility.

Considering the candidate nuclear power plants that best meet the technical requirements of the multiple reactor scenario, most operating licenses will have expired by 2030. Nonetheless, and even with conservative predictions of license renewal, there should be sufficient operating units to support tritium generation requirements until 2050.

**Economic Regulation/Financial Impact Issues.** In the economic, financial, and regulatory arena, there are no legislative or policy guidelines that deal specifically with tritium production in commercial reactors. The Federal Energy Regulatory Commission has no regulatory authority over reactor operation, but local state public utility commissions could exercise some control over dual use through their regulation of utility income and profitability. There is only one instance where a commercial reactor has been used to produce radioisotopes; however, this occurred almost 30 years ago.

There are several financial options that could be pursued to take a commercial reactor to dual use. Because dual use does not significantly increase "dual use arrangements," insurance and indemnity are not expected to change, including coverage under the *Price-Anderson Act.*

## 4.11 Unavoidable Adverse Environmental Impacts

Siting, construction, and operation of tritium supply and recycling facilities at INEL, NTS, ORR, Pantex, or SRS would result in adverse environmental impacts. The impact assessment conducted in this PEIS has identified these potential adverse impacts along with mitigative measures that could be implemented to either avoid or minimize these impacts. The residual adverse impacts remaining following mitigation are unavoidable and the worst case impacts of all alternatives at all candidate sites are discussed below.

At each of the candidate sites, up to 560 acres of land could be disturbed to construct and operate the new tritium supply and recycling facilities and additional supporting infrastructure and access roads. Loss of habitat in the disturbed area would be unavoidable,

but would represent less than 2 percent of the total area of all sites except for Pantex, which represents 4 percent. Soil erosion in the disturbed area due to wind and stormwater runoff would be minor. Small areas of potential wetlands could be unavoidably impacted, but mitigation measures approved by the U.S. Corps of Engineers would be implemented. Construction of both the MHTGR and APT would require deep excavations resulting in removal of a large volume of soil and dewatering operations. Reuse of this soil as fill and treatment of dewatering effluent would mitigate much of this adverse impact.

Cooling towers associated with evaporative cooling systems for the HWR, MHTGR, and ALWR at ORR and SRS would impact visual resources through their physical structure and vapor plumes which are visible during certain atmospheric conditions. Construction of tritium supply and recycling facilities would change the VRM classification to Class 5 at NTS, ORR, or SRS. Generally there would be no change in the overall appearance from key viewpoints with high sensitivity levels, except at ORR. Construction of up to 62 miles of transmission lines would have an unavoidable impact on visual views. Major modifications to the electrical power infrastructure are required for certain alternatives to provide the additional electric load capability required to support the tritium missions.

Construction and operation of tritium supply and recycling facilities would generate criteria and toxic/hazardous pollutants that have the potential to exceed Federal and state ambient air quality standards and guidelines. Concentrations of $PM_{10}$ and total suspended particulates are expected to be close to or exceed the 24-hour ambient $PM_{10}$ and TSP standards during peak construction periods under dry and windy conditions. Such exceedances are not uncommon for large construction projects. Air pollutant concentrations during operation would be greater than No Action concentrations, but are expected to remain within Federal and state ambient air quality standards.

For each of the technologies considered, use of water for cooling system requirements is unavoidable and could represent an adverse impact depending on the site. The maximum amount of surface water required for tritium facility operation would be about 15,500 MGY, and the maximum total site groundwater requirement would be 35,000 MGY at SRS. Cooling system water used at ORR and SRS would be taken from the Clinch River and Savannah River, respectively. There would be some unavoidable impact to aquatic biota from the loss of fish, larvae, and fish eggs due to entrainment and impingement at water intakes. Increased turbidity during construction activities could impact some fish spawning and feeding habitat. It is expected that this loss would be small in comparison with resident fish populations and reproductive capabilities. At sites where cooling water comes from groundwater, the maximum amount of water withdrawn for tritium supply and recycling operation is about 2,000 MGY for the APT alternative. At NTS, this amount of groundwater usage exceeds the lowest estimated recharge rate by 19 percent; depletion of the aquifer would occur, but would not be expected to impact offsite springs.

Cooling system blowdown activities discharge great quantities of water to surface waters over short-duration periods (e.g., 26 million gallons over a one hour period, once a day). This blowdown without mitigation would increase stream velocity, causing scouring of stream beds, erosion of stream channels, increased turbidity, resuspension and deposition of contaminated sediments in downstream areas, and potential flooding of areas at either ORR or SRS. Without mitigation, blowdown discharges could (1) alter the aquatic ecosystem by displacing existing plant and animal communities, (2) exceed water quality standards or NPDES discharge requirements, or (3) result in thermal impacts.

Federal-listed threatened or endangered species, such as the desert tortoise, bald eagle, short-nosed sturgeon and wood stork, could be affected directly or by disruptions to benthic and foraging habitats during construction and operation of tritium supply and recycling facilities. Several candidate or state-listed animal species and special status plant species may also be affected at different sites. Where potential conflicts occur, mitigation measures would be developed in consultation with the USFWS. While such disruptions may be unavoidable, appropriate measures would be implemented and monitored to ensure that any impacts are not irreversible. Construction of new facilities would have some adverse unavoidable effects on animal populations. Larger mammals and birds would move to similar habitats nearby, while less mobile animals within the

project areas, such as amphibians, reptiles and small mammals, would be destroyed during land-clearing activities. Drift from cooling towers for reactors may cause some unavoidable salt deposition on surrounding land areas and vegetation at or near the tritium supply site at a rate at which salt stress symptoms could become evident on sensitive plants.

Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area at each candidate site. The appropriate State Historical Preservation Officers would be consulted to minimize unavoidable adverse impacts. Native American resources may be unavoidably affected by land disturbance and audio or visual intrusions on Native American sacred sites or due to reduced access to traditional use areas. DOE would consult with the affected tribes to minimize any impacts.

With the onset of construction and operation of tritium supply and recycling facilities, the site and regional population would increase by as much as 13,700 during APT construction at NTS or 5,500 during full HWR operation at NTS. Population and housing could increase by up to 5 percent during construction and 2 percent during operation. There would be an associated increased burden on community infrastructure while subsequent effects on the public finances of local governments in the region of influence would be for the most part positive. An increase in vehicle traffic associated with construction and operation of tritium supply and recycling facilities would affect the roads and transportation network surrounding some of the candidate sites. The resulting impacts in traffic, congestion, and road accidents resulting from socioeconomic growth is unavoidable, but can be reversed. For example, site access roads which are degraded during construction can be upgraded beyond their original condition to accommodate increased worker traffic.

Some amount of radiation would be released unavoidably by normal tritium supply and recycling operations. The greatest radiation dose to the maximally exposed member of the public would be 8.8 mrem per year from atmospheric releases and 14 mrem from liquid releases at ORR. The associated risk of fatal cancers from 40 years of operations with these doses is $4.6 \times 10^{-4}$. The greatest annual population dose from total site operations through the year 2030 is 340 person-rem which occurs at SRS; such a total dose would result in 6.8 fatal cancers over the entire 40 years of operations. The largest average annual dose to a site worker is 140 mrem at NTS and would result in an associated risk of fatal cancer of $2.3 \times 10^{-3}$ from 40 years of operations. The greatest annual dose to the total site workforce is 650 person-rem occurring at SRS and would result in 10 fatal cancers over 40 years of operations.

Since hazardous and toxic chemicals are present during construction and operation of tritium facilities, worker exposure to these chemicals is unavoidable. The maximum hazard to site workers, based solely on emissions of hazardous chemicals, is represented by a hazard index of 1.81 at SRS, which exceeds the OSHA action level of 1.0. Cancer risks to the public and site workers are $3.3 \times 10^{-5}$ and $5.9 \times 10^{-3}$ respectively; both values exceed the typical acceptable standard of $1.0 \times 10^{-6}$. The use of remote, automated, and robotic production methods are being developed to reduce this worker exposure. Substitution of less toxic solvents would also result in reductions of the hazard index and possible complete elimination of the cancer risk. Other mitigative and protective measures would minimize this expected exposure to hazardous and toxic chemicals.

Spent nuclear fuel would be generated as an unavoidable result of reactor operations to produce tritium. Each of the candidate sites would require construction of a new spent fuel temporary storage facility. Although each site would implement waste minimization techniques, generation of additional low-level, hazardous and nonhazardous wastes is unavoidable. Any introduction of new waste types could be an adverse impact since treatment, storage, and disposal facilities may have to be developed and permitted to deal with certain new types of wastes. In addition, the generation of additional LLW would require a new treatment facility for liquid waste at Pantex and a new staging facility for solid LLW, prior to additional off site shipments. Generation of additional hazardous or mixed wastes could require expansion of existing or planned treatment, storage, and disposal facilities for these wastes at some sites. Generation of additional nonhazardous wastes may also require expansion of existing, or construction of new, liquid and solid waste treatment facilities or reduce the lifetimes of current solid waste landfills.

## 4.12 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The use of land on any of the five candidate sites being considered for tritium supply and recycling facilities would enhance the long-term productivity of each site in two ways. First, tritium missions represent a long-term production function compatible with historic nuclear weapons support and requires a skilled and stable workforce. Second, since existing facilities suitable to produce tritium do not exist, DOE plans to construct new, modern tritium supply facilities that will enhance the long-term productivity of the selected site.

Each alternative requires the use of additional land for additional disposal of radiological and hazardous materials. Such short-term usage would remove this land from other beneficial uses indefinitely because of the presence of long-lived hazards. Disposal of solid nonhazardous waste generated from tritium supply and recycling facilities construction and operations would require additional land at onsite sanitary landfills. Solid nonhazardous waste generated from these facilities would continuously require additional land at a sanitary landfill site which would be unavailable for other uses in the long term. LLW would require additional space for onsite storage and waste processing and would involve the commitment of associated land, transportation, processing facilities, and other disposal resources. Creation of land disposal facilities allows the site to be productive for the long-term by protecting the overall environment and complying with Federal and state environmental requirements.

Two specific activities have been identified that require short-term resource uses which could compromise long-term productivity. At Pantex, construction of tritium supply and recycling facilities would displace existing agricultural uses on soils classified as prime farmland. The range of the endangered desert tortoise lies in the southern third of NTS. The proposed TSS is located near one of the areas on NTS having a relatively high number of desert tortoises compared to the rest of the site. Construction and operation of tritium facilities could pose a threat to both individual tortoises and their habitat. Measures designed to avoid impacts to the desert tortoise from previous projects at NTS have been implemented with mitigation measures developed in consultation with USFWS.

Losses of other terrestrial and aquatic habitats from natural productivity to accommodate new facilities and temporary disturbances required during construction of these facilities are possible. Land clearing and construction activities resulting in large numbers of personnel and equipment moving about an area would disperse wildlife and temporarily eliminate habitats. Although some destruction would be inevitable during and after construction, these losses will be minimized by site selection and thorough environmental reviews at the site-specific level. In addition, short-term disturbances of previously undisturbed biological habitats from the construction of new facilities could cause long-term reductions in the biological productivity of an area. These long-term reductions could occur, for example, at facilities located in arid areas of the western United States such as at INEL and NTS, where biological communities recover very slowly from disturbances. Additional nuclear operations at SRS and ORR could affect wetlands habitat and aquatic biota because of cooling water withdrawals and thermal effluent discharges. These impacts could be mitigated by avoiding sensitive areas, reducing water withdrawals, and reducing the temperature of thermal discharges through the use of cooling towers.

Termination of activities at the SRS offers the possibility of restoring existing facilities at that site to another purpose. Environmental restoration activities could have minor or short-term impacts similar to those normally associated with construction activities, such as habitat disturbance and soil erosion. If contaminated structures were removed and site areas restored to a natural state, these areas could provide improved conditions for the long term.

## 4.13 Irreversible and Irretrievable Commitments of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when its primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither

renewable nor recoverable for later use by future generations.

The tritium supply and recycling facility proposal was initiated to ensure a continuing and secure supply of tritium for the Complex. As such, the programmatic decisions resulting from this PEIS will ensure the commitment of resources to new construction and renovation of tritium facilities at locations in line with the future workloads and long-range nuclear weapons production strategy. This section discusses three major resource categories that are committed irreversibly or irretrievably to the proposed action: land, materials, and energy.

**Land Use.** The land that is currently occupied by, or designated for, future tritium supply and recycling facilities, could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other nuclear programs. Therefore, the commitment of this land is not necessarily irreversible.

However, land rendered unfit for other purposes, such as that set aside for radiological and hazardous chemical waste disposal facilities, represents an irreversible commitment because wastes in below-ground disposal areas may not be completely removed at the end of the project. The land could not be restored to its original condition or to minimum cleanup standards, nor could the site feasibly be used for any other purposes following closure of the disposal facility. This land would be perpetually unusable because the substrata would not be available for other potential intrusive uses such as mining, utilities, or foundations for other buildings. However, the surface area appearance and biological habitat lost during construction and operation of the facilities could to a large extent be restored.

**Material.** The irreversible and irretrievable commitment of material resources during the entire life-cycle of tritium facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive but cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. At this time, no unusual construction material requirements have been identified either as to type or quantity. The construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost. However, none of these identified construction resources is in short supply and all are readily available in the vicinity of locations being considered for new facilities. The commitment of materials to be manufactured into new equipment that cannot be recycled at the end of the project's useful lifetime is irretrievable. Consumption of operating supplies, miscellaneous chemicals, and gases, while irretrievable, would not constitute a permanent drain on local sources or involve any material in critically short supply in the United States as a whole. Materials consumed or reduced to unrecoverable forms of waste, such as uranium, are also irretrievably lost. However, strategic and critical materials, or resources having small natural reserves, are of such value that economics promotes recycling. Plans to recover and recycle as much of these valuable, depletable resources as is practical should depend on need and each item would be considered individually at the time a recovery decision is required.

**Energy.** The irretrievable commitment of resources during construction and operations of the facilities would include the consumption of fossil fuels used to generate heat and electricity for the sites. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amount of energy required to operate the tritium facilities is estimated in section 3.4.2 and would be irretrievable. These estimates are roughly comparable to past energy requirements except for the APT, which represents a significant increase over amounts historically consumed for operation of tritium supply facilities.

## 4.14 Facility Transition

The final disposition of all Complex facilities is the responsibility of EM. DOE is committed to remediate these sites, to comply with all applicable environmental requirements, and to protect public and worker health and safety. DOE is currently considering many technologies for the treatment of contaminated materials and equipment, and for the long-term management of sites. DOE is preparing a PEIS to identify configurations for selected waste management facilities. The term "configurations" as used in

this context means the arrangement of facilities and related activities at one or more DOE sites for a specific waste type. The selected waste management facilities for each of these waste types are: interim storage facilities for treated HLW; treatment and storage facilities for TRU waste in the event that treatment is required before disposal; treatment and disposal facilities for LLW and interim storage facilities for commercial Greater-Than-Class C LLW; treatment and disposal facilities for mixed LLW; and treatment facilities for hazardous waste.

At the end of their useful life, all facilities (new ones and those phased out as a result of mission changes) would undergo transition to EM. Facility transition begins when the Program Secretarial Office or the Secretary of Energy determines that there is no further need for a facility. The transition process involves developing a transition plan, the deactivation and preliminary characterization of the facility against turnover requirements, preparation of budget requests, and other necessary planning and information exchange activities. Each transition plan will incorporate site-specific details and define actions necessary to bring identified facilities into a condition acceptable for transfer to EM. The facility would be accepted by EM after the acceptance criteria are met. Deactivation of the facility could include the removal of usable equipment and material, classified documents, and parts of other activities in order to reduce the long-term surveillance and maintenance costs. Ideally, deactivation would be completed prior to turnover to EM. However, turnover to EM may occur at any time between formal acceptance and completion of deactivation activities, including the possibility of turnover occurring at the time of acceptance. Timing of acceptance, deactivation, and turnover to EM is controlled by funding, political, and departmental workload considerations. Facility transition ends when the facility has been turned over to EM for final disposition, including any decontamination and decommissioning (D&D).

It is important to recognize that the decisions to conduct near-term cleanup and D&D activities at the potential phaseout site do not depend on whether the proposals for tritium supply and recycling are implemented. Regardless of whether tritium recycling is phased out at SRS, substantial cleanup of both soil and groundwater contamination and substantial D&D of buildings already determined to be unnecessary for future operations are either occurring or planned. These cleanup and D&D activities represent a substantial percentage of the total scope of activities that must occur at the potential phaseout site. When specific proposals are completed for the D&D of facilities that would be phased out as a result of the implementation of the proposed tritium supply and recycling action, the appropriate NEPA documentation would be prepared. Depending on the level and type of contamination, D&D may involve: (1) decontamination and return of an area to its original condition without restrictions on use or occupancy or (2) partial decontamination and isolation of remaining residues with continued surveillance and restrictions on use or occupancy.

In making any final disposition decisions, DOE will face many complex issues, including: human resources; cost; future site use; public involvement; and health, safety, and environmental issues. Public involvement in facility transition activities would be considered in making the DOE facility transition and the associated environmental restoration program a success. DOE has established and will continue to establish transition working groups at the affected site to work with the public throughout the transition process.

In planning the transition of facilities and sites from a production mission to an environmental restoration mission, the following guidelines would be followed (DOE 1993e):

- Laws, regulations, formal agreements, and DOE orders will form the basis for transition planning and execution.
- Transition planning will be coordinated with the appropriate regulatory agencies, host state, and other affected stakeholders.
- All vital safety and utility systems within the affected facility will be fully functional upon transfer.
- Facilities will have a current safety analysis report and other technical safety requirements that address the change in facility mission and condition of the facility at the time of turnover.

- Facilities used in waste management operations or other support functions will remain operational as required to support future environmental restoration activities, including facility decontamination and dismantlement.

- Management of waste streams during the transition period will be in accordance with existing regulations.

- A systems engineering risk assessment approach will be used to determine future site and facility uses and possible directions for achieving them.

The required level of effort to complete D&D of facilities would be a function of the types of chemical and radiological materials utilized when the facility was operational, and the extent to which radioactive and hazardous/toxic materials have been deposited on the internal and external surfaces of components, systems, and structures.

In sequence, the steps to accomplish D&D of a facility associated with weapons reconfiguration are: (1) deactivation—DP characterizes the facility waste; (2) facility is transferred to EM; (3) facility is decontaminated; and (4) final disposition.

Because designs are preconceptual, it is impossible to analyze potential impacts at this time. However, a relative comparison of D&D activities and potential impacts between the tritium supply technologies can be made. It is expected that the APT would have the smallest impact from D&D activities. Although extensive excavation may be required to remove the tunnel, the amount and level of activity for radioactively contaminated waste volumes would be considerably less than the reactor technologies. Because of multiple reactor vessels and the fact that its reactor vessels are below grade, the MHTGR would probably have the largest impact from D&D activities. Because of fuel and target fabrication being done offsite, the impacts from D&D for the ALWR and HWR would be similar. Radiological impacts from D&D activities to the general population are expected to be negligible. All D&D activities would be regulated by DOE orders. Exposure limits to the general population would be similar to exposure limits for facility operations.

## 4.15 Environmental Justice in Minority and Low-Income Populations

DOE is committed, to the greatest extent practicable and permitted by law, to achieving environmental justice as part of its tritium supply and recycling mission. Previous section of chapter 4 describes the employment, population, income, housing, public finance, and regional economics surrounding each candidate site. Impacts to these socioeconomic issue areas due to the implementation of the proposed action at these sites are also discussed. Selected demographic characteristics of the region-of-influence for each of the five candidate sites is presented in tables 4.15–1 through 4.15–5 and figures 4.15–1 through 4.15–8. DOE has attempted in this PEIS, and will continue in subsequent tiered NEPA documents, to identify and to mitigate when so identified, any disproportionately high and adverse human health or environmental effects on minority and low-income populations resulting from decisions based on this PEIS for Tritium Supply and Recycling.

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations," directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. Executive Order 12898 also directs the Administrator of EPA to convene an interagency Federal Working Group on Environmental Justice. The Working Group is directed to provide guidance to federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority and low-income populations. The Working Group has not yet issued the guidance directed by Executive Order 12898. In coordination with the Working Group, the Department is in the process of developing internal guidance on implementing the Executive Order. Because both the Working Group and the Department are still in the process of developing guidance, the approach taken in this analysis may depart somewhat from whatever guidance is eventually issued.

This PEIS analyzes the demographic information presented in the tables and figures contained in this section. For analysis, the shaded areas in figures 4.15–1, 4.15–3, 4.15–5, and 4.15–7 show census

tracts where people of color comprise 50 percent or (simple majority) of the total population in the census tract, or where people of color comprise less than 50 percent but greater than 35 percent of the total population in the census tract. Figures 4.15–2, 4.15–4, 4.15–6, and 4.15–8 show low-income communities generally defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than $8,076 for a family of two). Since no minority or low income populations live within a 50-mile radius of NTS, no NTS maps are included. This analysis considers any disproportionately high and adverse human health or environmental effects on minority populations and low-income populations could result from the alternatives being considered. As shown in section 4.11, Unavoidable Adverse Environmental Impacts, impacts, if any, to surrounding communities would most likely result from toxic/hazardous air pollutants and radiological emissions. As further shown in sections 4.2.3.9, 4.3.3.9, 4.4.3.9, 4.5.3.9, and 4.6.3.9 on Radiological and Hazardous Chemical Impacts During Normal Operation and Accidents, these emissions are expected to be lower than regulatory limits. While these releases and emissions are within regulatory limits, the cumulative effect of continuous (or intermittent over time) very low level exposures could have some impact on human health or the environment. Therefore, whatever adverse human health or environmental impacts to any offsite populations, would most likely occur to people living within communities located near the five candidate sites. The analysis of the demographics data presented in figures 4.15–1 through 4.15–8, tables 4.15–1 through 4.15–5 and for the communities surrounding the five candidate sites indicates that even if there were any health impacts to these communities, these impacts would not appear to disproportionately affect minority or low-income populations.

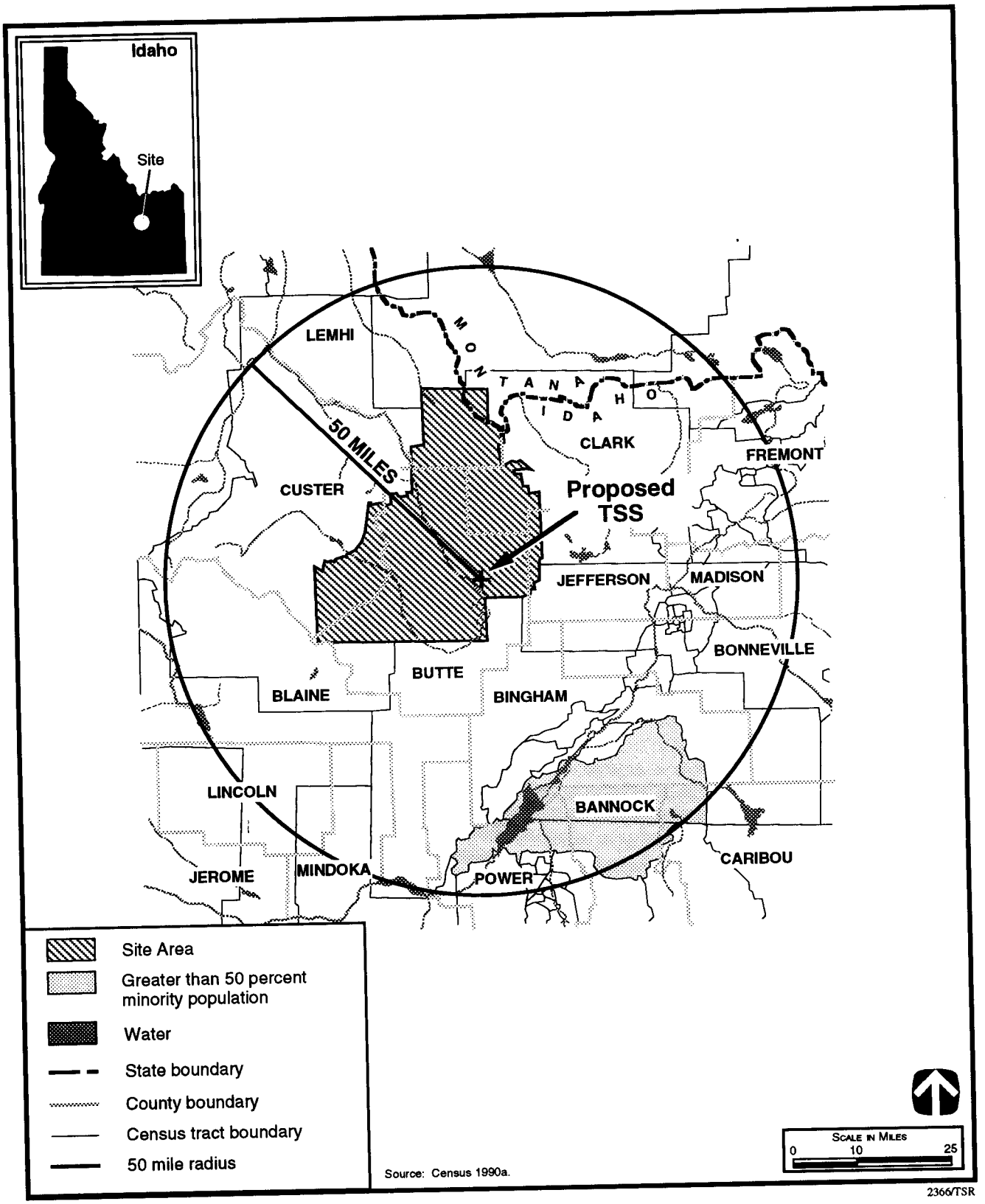
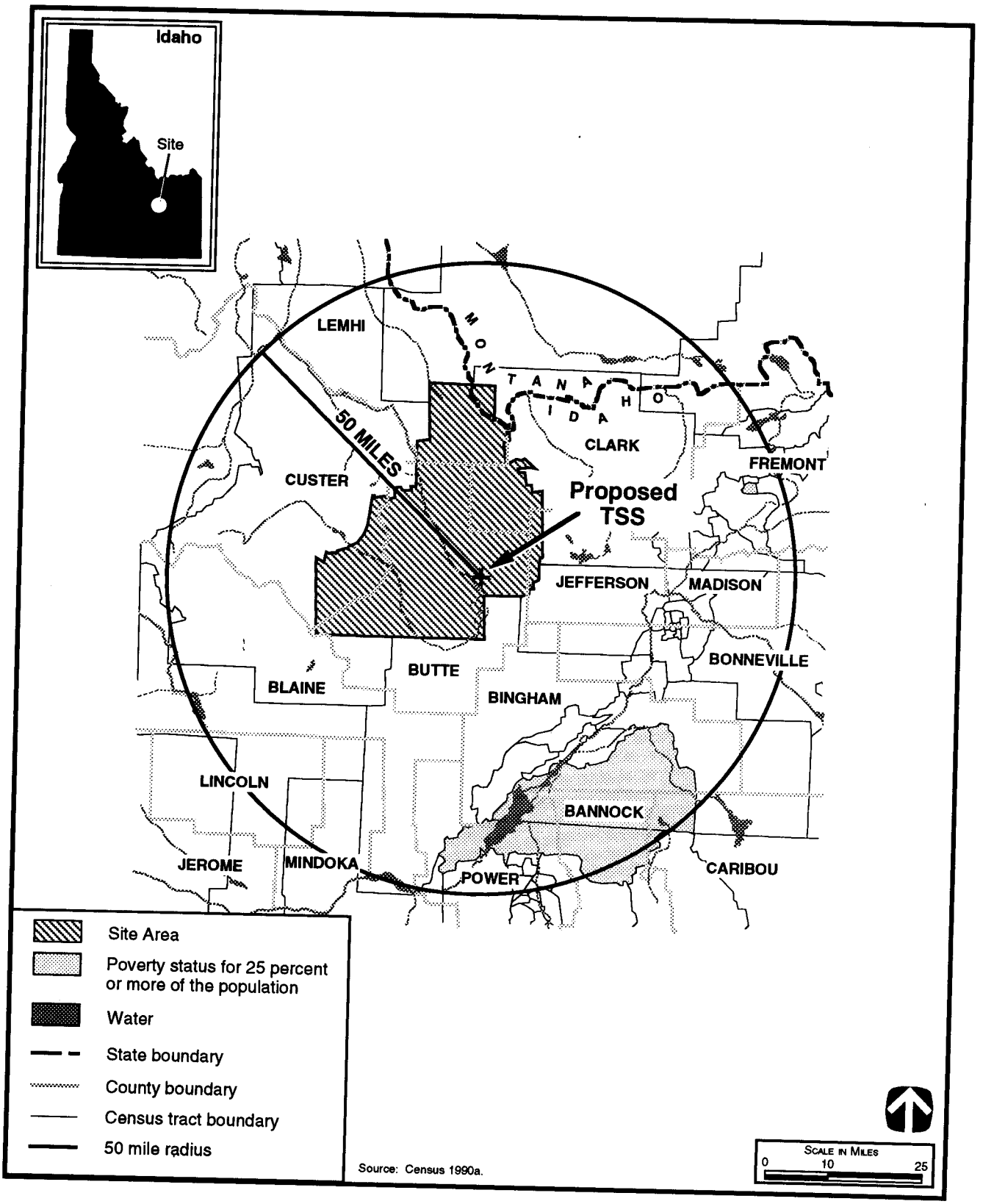



**FIGURE 4.15–1.**—***Minority Population Distribution for Idaho National Engineering Laboratory and Surrounding Area.***




2365/TSR

**FIGURE 4.15–2.**—***Low Income Distribution by Poverty Status for Idaho National Engineering Laboratory and Surrounding Area.***

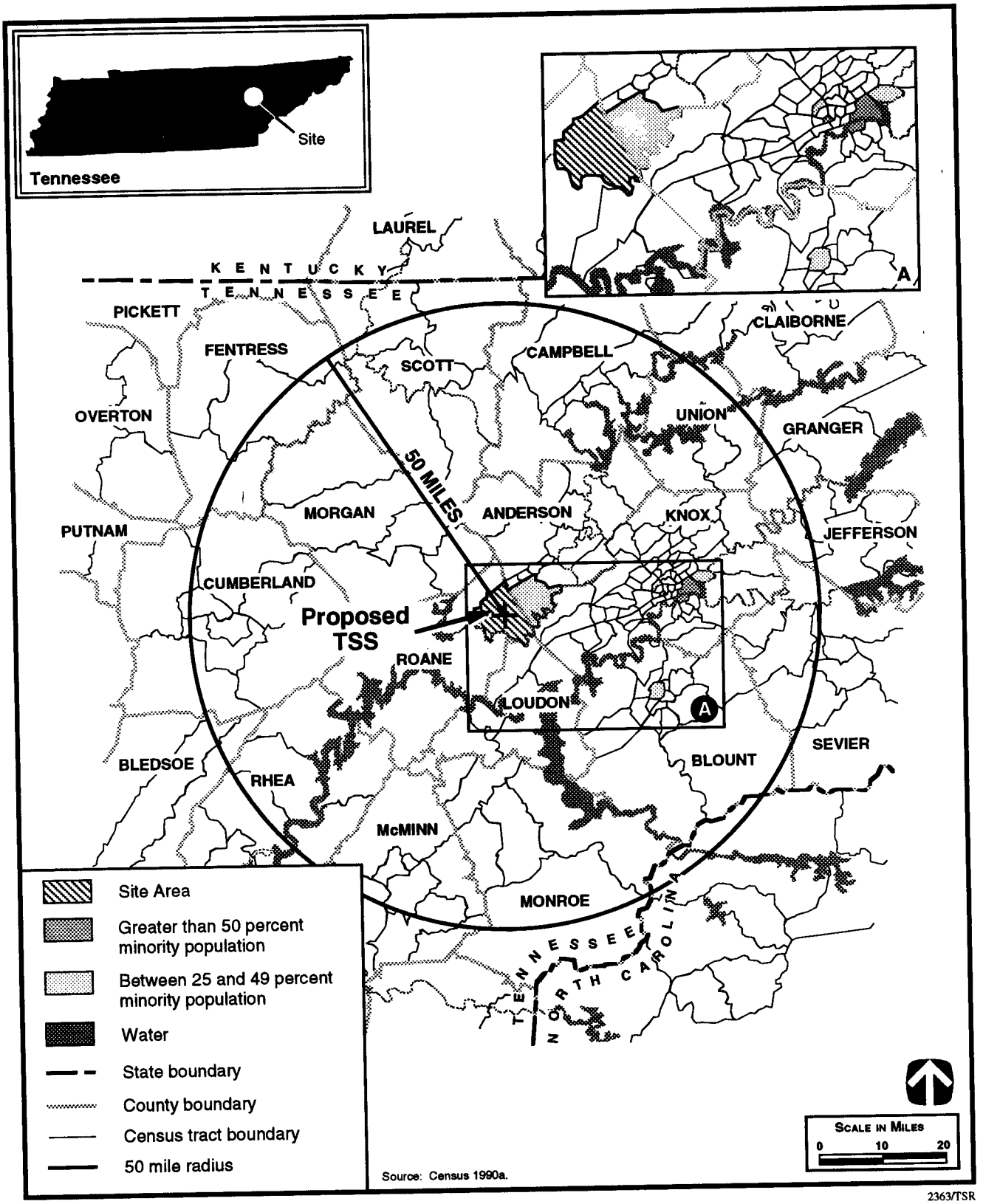
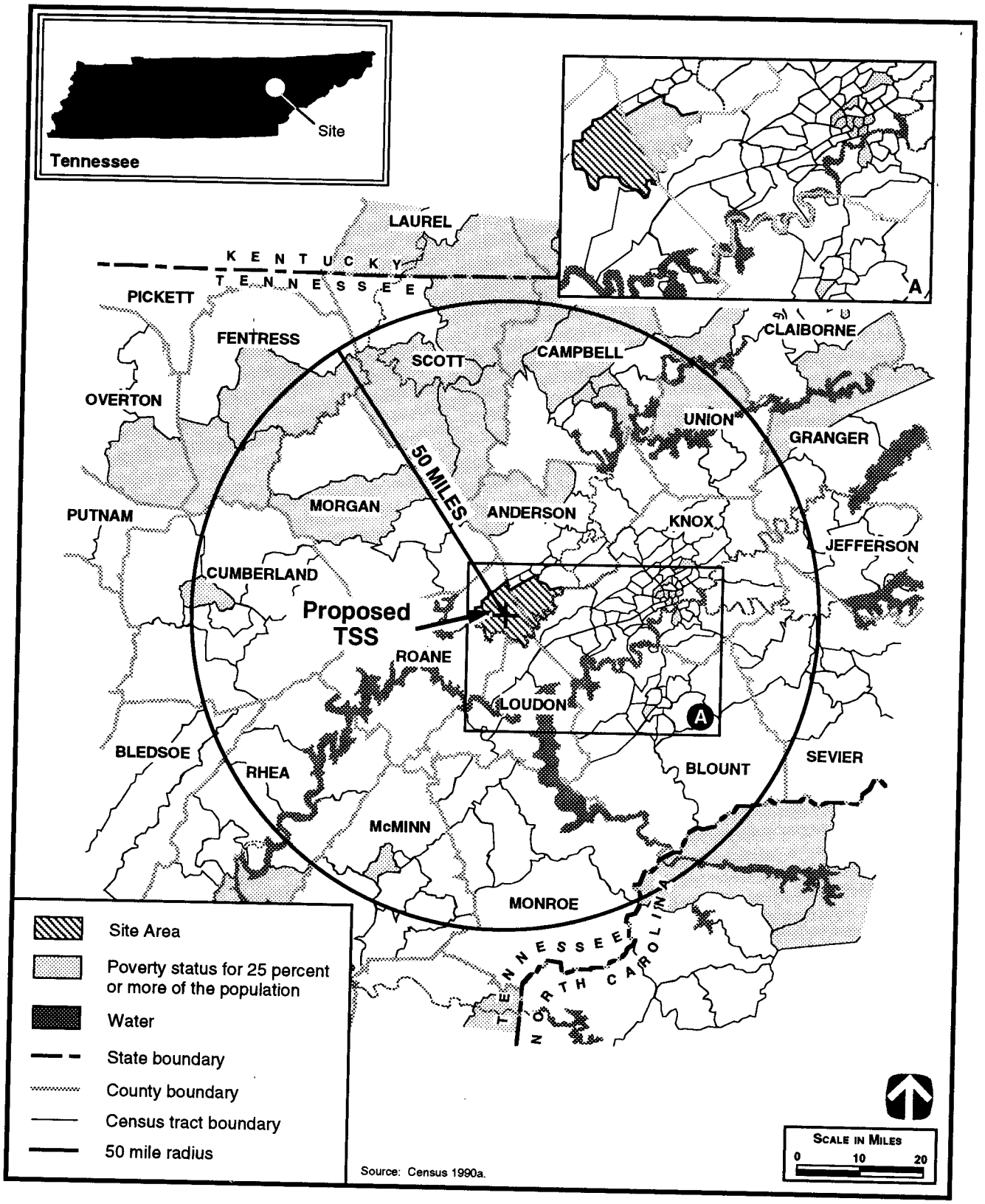



**FIGURE 4.15–3.**—***Minority Population Distribution for Oak Ridge Reservation and Surrounding Area.***




2364/TSR

**FIGURE 4.15–4.**—*Low Income Distribution by Poverty Status for Oak Ridge Reservation and Surrounding Area.*

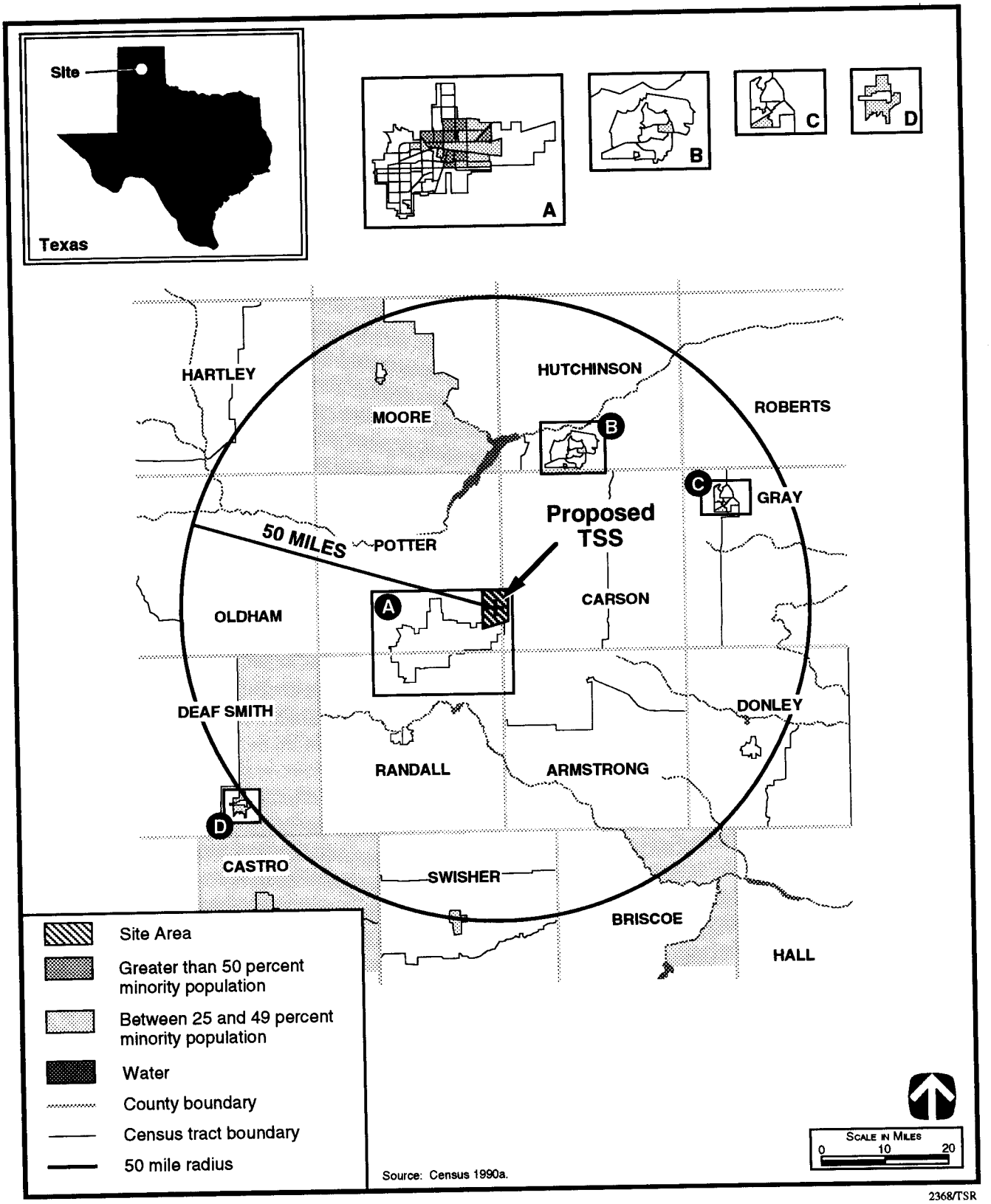
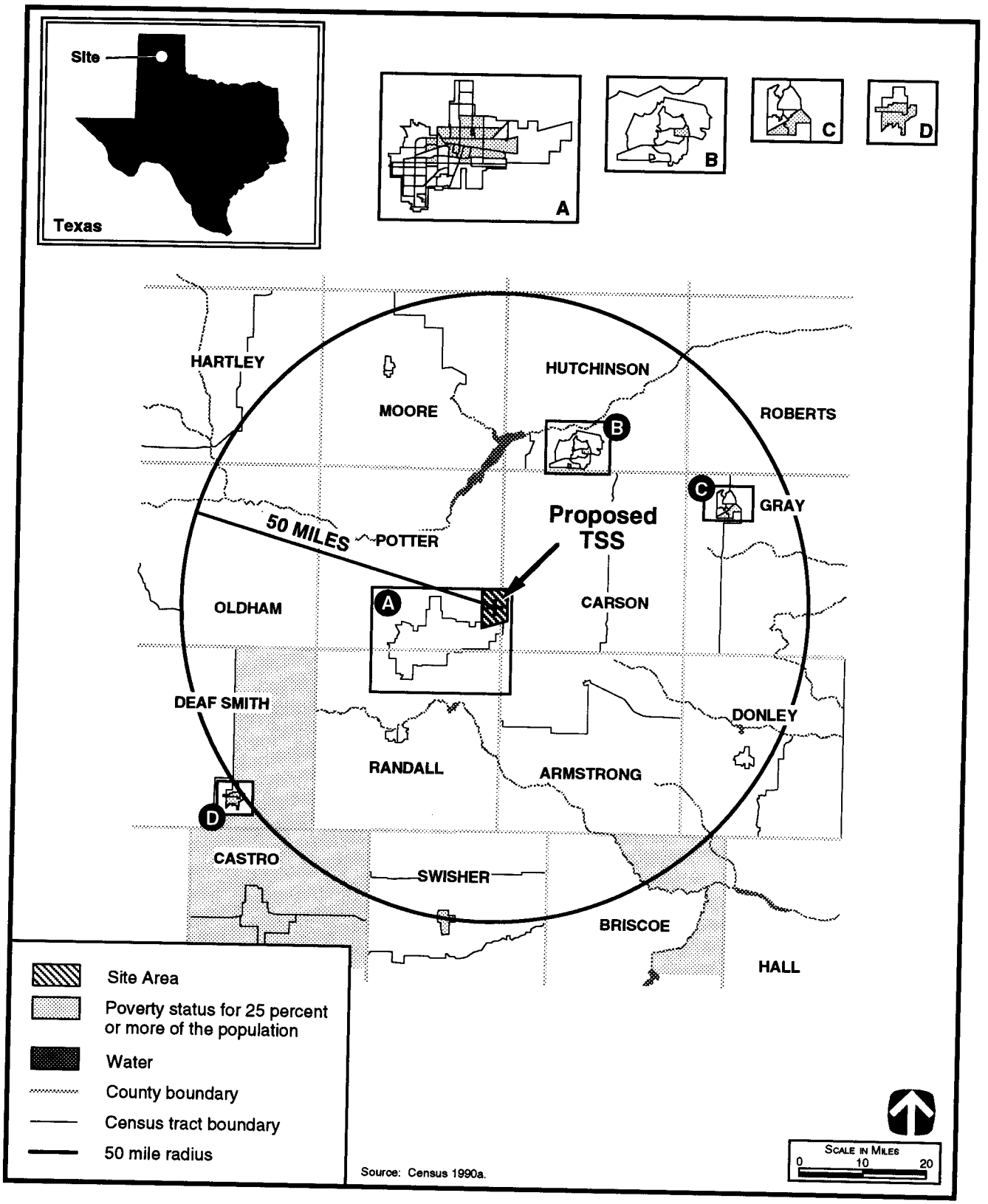
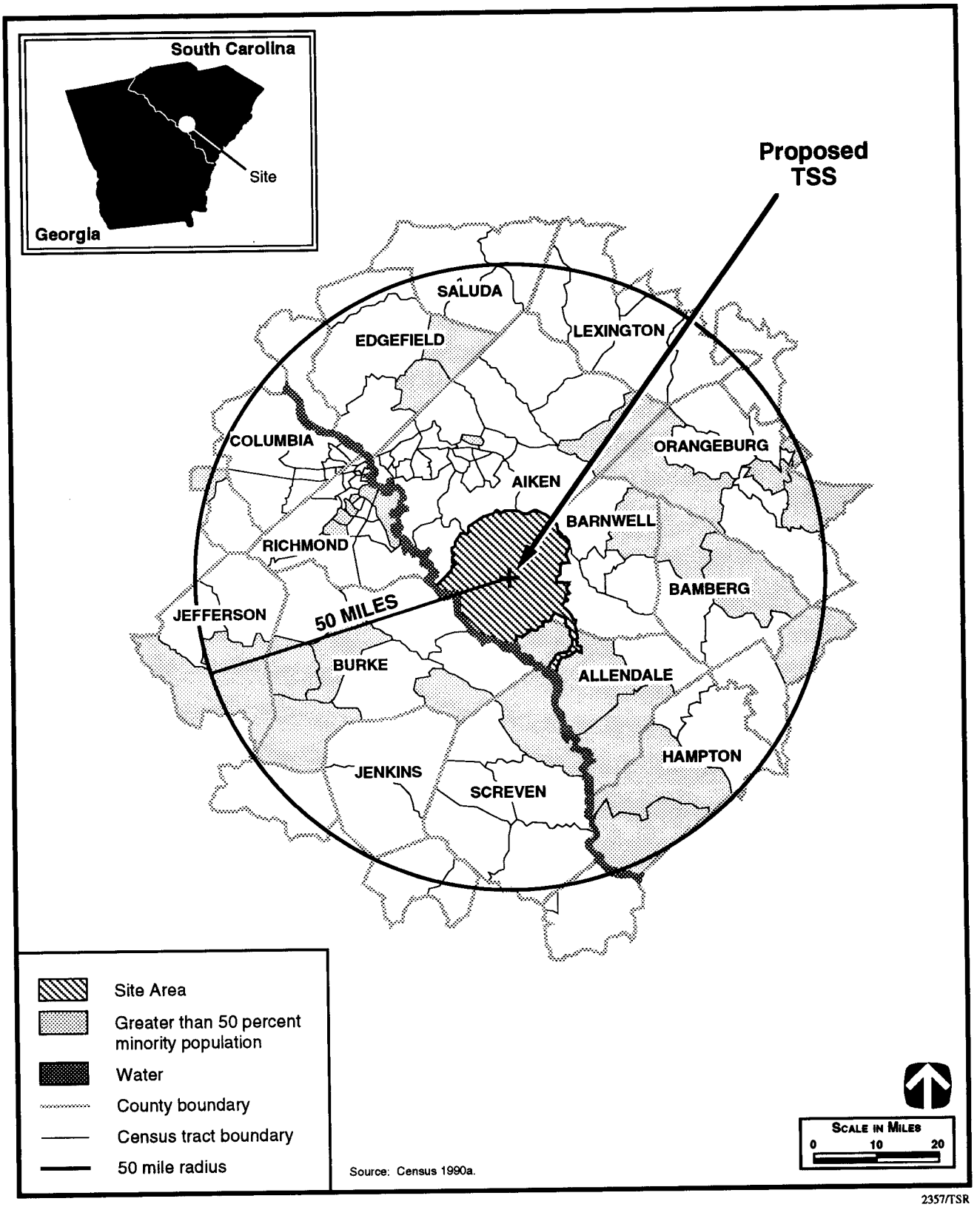



**FIGURE 4.15–5.**—***Minority Population Distribution for Pantex Plant and Surrounding Area.***



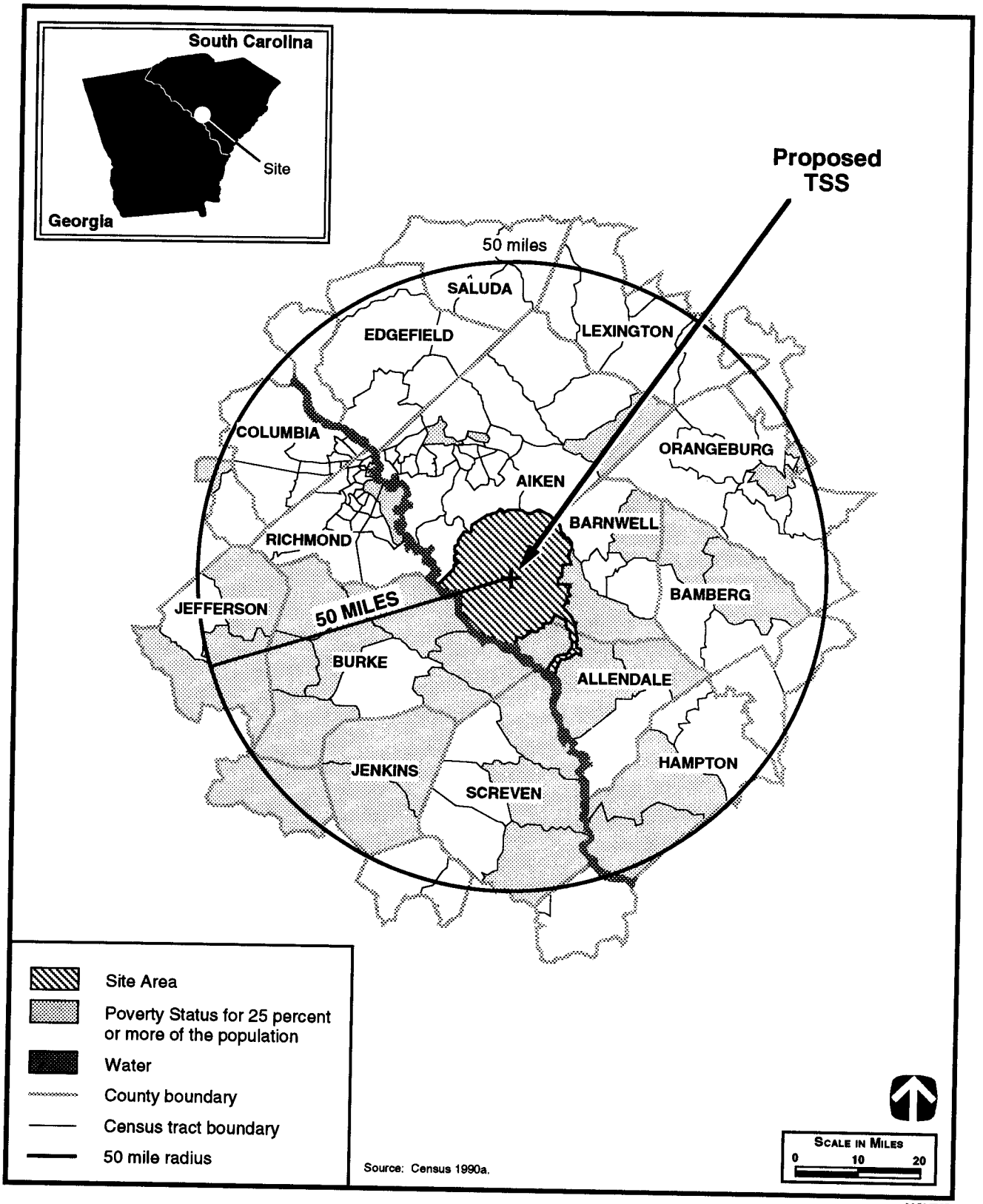

2367/TSR

**FIGURE 4.15–6.**—*Low Income Distribution by Poverty Status for Pantex Plant and Surrounding Area.*




2357/TSR

**FIGURE 4.15–7.**—***Minority Population Distribution for Savannah River Site and Surrounding Area.***




2358/TSR

**FIGURE 4.15–8.**—*Low Income Distribution by Poverty Status for Savannah River Site and Surrounding Area.*

**TABLE 4.15–1.—*Selected Demographic Characteristics for Idaho National Engineering Laboratory Region-of-Influence***

| Characteristic/Area | Bannock County (number) | Bingham County (number) | Bonneville County (number) | Butte County (number) | Jefferson County (number) | Total Region-of-Influence (number) | Total Region-of-Influence (percent) |
|---|---|---|---|---|---|---|---|
| **Persons by Race/Ethnicity** | | | | | | | |
| Non-Hispanic, White | 60,626 | 31,432 | 67,879 | 2,791 | 15,219 | | |
| Hispanic | 2,740 | 3,614 | 3,010 | 101 | 1,155 | | |
| Non-Hispanic, American Indian | 1,509 | 2,209 | 343 | 21 | 109 | | |
| Non-Hispanic, Black | 415 | 31 | 286 | 0 | 3 | | |
| Non-Hispanic, Asian/Pacific Islander | 697 | 284 | 663 | 5 | 40 | | |
| Non-Hispanic, Other | 39 | 33 | 26 | 0 | 17 | | |
| **Total 1990 Population** | 66,026 | 37,583 | 72,207 | 2,918 | 16,543 | | |
| **Total Number of Households** | 23,412 | 11,513 | 24,289 | 997 | 4,871 | | |
| **1989 Low Income** | | | | | | | |
| ***Persons Below Poverty*** | | | | | | | |
| Number | 8,944 | 5,804 | 7,056 | 392 | 2,353 | | |
| Percent | 13.8 | 15.6 | 9.9 | 13.5 | 14.3 | | |

Source: Census 1990a.

**TABLE 4.15–2.—*Selected Demographic Characteristics for Nevada Test Site Region-of-Influence***

| Characteristic/Area | Clark County (number) | Nye County (number) | Total Region-of-Influence (number) | Total Region-of-Influence (percent) |
|---|---|---|---|---|
| **Persons by Race/Ethnicity** | | | | |
| Non-Hispanic, White | 558,875 | 15,635 | 574,510 | 75.7 |
| Hispanic | 82,904 | 1,237 | 84,141 | 11.1 |
| Non-Hispanic, American Indian | 5,514 | 475 | 5,989 | 0.8 |
| Non-Hispanic, Black | 68,858 | 274 | 69,132 | 9.1 |
| Non-Hispanic, Asian/Pacific Islander | 24,483 | 148 | 24,631 | 3.2 |
| Non-Hispanic, Other | 825 | 12 | 837 | 0.1 |
| **Total 1990 Population** | 741,459 | 17,781 | 759,240 | 100.0 |
| **Total Number of Households** | 287,025 | 6,664 | 293,689 | |
| **1989 Low Income** | | | | |
| ***Persons Below Poverty*** | | | | |
| Number | 76,737 | 1,840 | 78,577 | |
| Percent | 10.3 | 10.3 | 10.3 | |

Source: Census 1990a.

**TABLE 4.15–3.—*Selected Demographic Characteristics for Oak Ridge Reservation Region-of-Influence***

| Characteristic/Area | Anderson County (number) | Knox County (number) | Loudon County (number) | Roane County (number) | Total Region-of-Influence (number) | Total Region-of-Influence (percent) |
|---|---|---|---|---|---|---|
| **Persons by Race/Ethnicity** | | | | | | |
| Non-Hispanic, White | 64,320 | 300,040 | 30,668 | 45,274 | 440,302 | 91.2 |
| Hispanic | 381 | 2,067 | 83 | 212 | 2,743 | 0.6 |
| Non-Hispanic, American Indian | 236 | 775 | 52 | 95 | 1,158 | 0.2 |
| Non-Hispanic, Black | 2,753 | 29,483 | 400 | 1,456 | 34,092 | 7.1 |
| Non-Hispanic, Asian/Pacific Islander | 537 | 3,263 | 49 | 186 | 4,035 | 0.8 |
| Non-Hispanic, Other | 23 | 121 | 3 | 4 | 151 | 0.0 |
| **Total 1990 Population** | 68,250 | 335,749 | 31,255 | 47,227 | 482,481 | 99.9 |
| **Total Number of Households** | 27,384 | 133,639 | 12,155 | 18,453 | 191,631 | |
| **1989 Low Income** | | | | | | |
| ***Persons Below Poverty*** | | | | | | |
| Number | | | | | | |
| Percent | 9,664 | 45,608 | 4,192 | 7,467 | 66,931 | |

Source: Census 1990a.

**TABLE 4.15–4.—*Selected Demographic Characteristics for Pantex Plant Region-of-Influence***

| Characteristic/Area | Armstrong County (number) | Carson County (number) | Potter County (number) | Randall County (number) | Total Region-of-Influence (number) | Total Region-of-Influence (percent) |
|---|---|---|---|---|---|---|
| **Persons by Race/Ethnicity** | | | | | | |
| Non-Hispanic, White | 1,951 | 6,158 | 66,877 | 81,364 | 156,350 | 79.7 |
| Hispanic | 55 | 354 | 19,246 | 6,144 | 25,799 | 13.1 |
| Non-Hispanic, American Indian | 9 | 41 | 709 | 414 | 1,173 | 0.6 |
| Non-Hispanic, Black | 0 | 11 | 8,460 | 1,082 | 9,553 | 4.9 |
| Non-Hispanic, Asian/ Pacific Islander | 5 | 9 | 2,431 | 626 | 3,071 | 1.6 |
| Non-Hispanic, Other | 1 | 3 | 151 | 43 | 198 | 0.1 |
| **Total 1990 Population** | 2.021 | 6,576 | 97,874 | 89,673 | 196,144 | 100.0 |
| **Total Number of Households** | 768 | 2,402 | 37,344 | 34,553 | 75,067 | |
| **1989 Low Income** | | | | | | |
| ***Persons Below Poverty*** | | | | | | |
| Number | 232 | 583 | 21,619 | 7,819 | 30,253 | |
| Percent | 11.5 | 8.9 | 22.1 | 8.7 | 15.4 | |

Source: Census 1990a.

**TABLE 4.15–5.—*Selected Demographic Characteristics for Savannah River Site Region-of-Influence***

| Characteristic/Area | South Carolina: Aiken County (number) | South Carolina: Allendale County (number) | South Carolina: Bamberg County (number) | Georgia: Barnwell County (number) | Georgia: Columbia County (number) | Georgia: Richmond County (number) | Total Region-of-Influence (number) | Total Region-of-Influence (percent) |
|---|---|---|---|---|---|---|---|---|
| **Persons by Race/Ethnicity** | | | | | | | | |
| Non-Hispanic, White | 90,130 | 3,598 | 6,428 | 11,421 | 56,141 | 103,009 | 270,727 | 63.6 |
| Hispanic | 867 | 161 | 75 | 146 | 962 | 3,707 | 5,918 | 1.4 |
| Non-Hispanic, American Indian | 213 | 11 | 22 | 31 | 150 | 491 | 918 | 0.2 |
| Non-Hispanic, Black | 29,176 | 7,939 | 10,356 | 8,677 | 7,239 | 79,221 | 142,608 | 33.5 |
| Non-Hispanic, Asian/Pacific Islander | 528 | 7 | 20 | 17 | 1,518 | 3,186 | 5,276 | 1.2 |
| Non-Hispanic, Other | 26 | 6 | 1 | 1 | 21 | 105 | 160 | 0.0 |
| **Total 1990 Population** | 120,940 | 11,722 | 16,902 | 20,293 | 66,031 | 189,719 | 425,607 | 99.9 |
| **Total Number of Households** | 44,883 | 3,791 | 5,587 | 7,100 | 21,841 | 68,675 | 151,877 | |
| **1989 Low Income** | | | | | | | | |
| ***Persons Below Poverty*** | | | | | | | | |
| Number | 16,671 | 3,837 | 4,547 | 4,367 | 4,255 | 32,590 | 66,267 | |
| Percent | 13.8 | 32.7 | 26.9 | 21.5 | 6.4 | 17.2 | 15.6 | |

Source: Census 1990a.

# CHAPTER 5

# Chapter 5

# CHAPTER 5: ENVIRONMENTAL, OCCUPATIONAL SAFETY & HEALTH, PERMITS AND COMPLIANCE REQUIREMENTS

***Chapter 5 identifies the environmental, occupational safety and health, permits, and compliance requirements associated with the proposed action as specified by the major Federal and state statutes, regulations, orders, and agreements.***

## 5.1 INTRODUCTION AND PURPOSE

Chapter 5 provides information concerning the environmental standards and statutory requirements that impact on the various tritium supply technologies and recycling facilities to the extent necessary to assist in making programmatic-level decisions. It presents some of the more important regulatory requirements associated with the proposed action by identifying the applicable environmental statutes, regulations, and approval requirements. These requirements are found in Federal and state statutes, regulations, permits, approvals, and consultations, as well as in Executive and Department of Energy (DOE) orders, consent orders, Federal Facility Agreements, Federal Facility Compliance Agreements, and Agreements In Principle. These documents provide the standard against which to evaluate the ability of candidate sites to meet the environment, safety, and health (ES&H) requirements at each site and to obtain required Federal and state permits and licenses necessary to implement programmatic decisions. The remainder of the chapter provides historical background on environmental protection at nuclear weapons production facilities, explains the concept of shared Federal and state enforcement, and summarizes compliance with occupational safety and health and environmental justice requirements.

Compliance with the applicable requirements of each of the major environmental statutes, regulations, or orders identified in the tables would allow DOE to construct and operate the tritium supply and recycling facilities to meet existing ES&H requirements. To be environmentally sound, programmatic decisions must also address the ES&H planning considerations described in section 3.3 of the *Nuclear Weapons Complex Reconfiguration Study* (DOE/DP-0083) in order for the tritium supply and recycling facilities to meet ES&H requirements which would exist in the future and to accomplish the mission in a timely and cost-effective manner.

## 5.2 BACKGROUND

Since the majority of the Nuclear Weapons Complex (Complex) facilities were constructed in the 1940's and 1950's before the advent of today's environmental and worker health requirements, safety and the ability to satisfy national security requirements played the dominant roles in the design and operation of these major industrial plants. With the emergence of an awareness of environmental and health-related issues and the enactment of environmental and worker health programs, however, DOE shifted a great deal of its resources into programs designed to achieve compliance with all applicable Federal, state, and local ES&H requirements. Today, many government agencies at the Federal, state, and local levels have regulatory authority over DOE facility operations. DOE has entered into enforceable compliance agreements with the regulators at most of its facilities. These agreements detail specific programs, funding levels, and schedules for achieving compliance with applicable ES&H statutory and regulatory requirements.

All newly constructed and modified facilities must comply with the increasing number and complexity of environmental regulations. The application of constantly changing requirements to facilities that are more than 40 years old makes it difficult to achieve compliance quickly. These older facilities generally do not meet all current standards for seismic design, fire protection, and environmental protection (air

emissions, liquid effluents, and the management of solid and hazardous wastes). However, modernization of facilities to meet all applicable ES&H requirements now and into the 21st century and the development of a system to adequately manage the wastes generated by these facilities would take place regardless of the proposed action addressed in this PEIS.

## 5.3 Environmental Statutes, Orders, and Agreements

The *Atomic Energy Act* of 1954 authorizes DOE to establish standards to protect health and minimize dangers to life or property with respect to activities under its jurisdiction. The Nuclear Regulatory Commission (NRC) is charged under the *Atomic Energy Act* and the *Energy Reorganization Act* of 1974 with jurisdiction over commercial reactor construction and operation. NRC also licenses and regulates the possession, use, transportation, and disposal of radioactive materials, including wastes. The Environmental Protection Agency (EPA), under authority of the *Atomic Energy Act*, has set radiation protection standards such as "Environmental Radiation Protection Standards for Nuclear Power Operations" (40 CFR 190). EPA has promulgated Federal environmental statutes and regulations to protect the environment and to control the generation, handling, treatment, storage, and disposal of hazardous materials and waste substances. Because of their length, and for ease of reading, all tables in this chapter are presented consecutively at the end of the text. Table 5.3–1 lists the applicable Federal environmental statutes, regulations, and Executive orders, and also identifies the associated permit, approval, and consultation requirements generally required to site, construct, or operate a tritium supply technology and recycling facility. Except for limited Presidential exemptions, Federal agencies must comply with all applicable provisions of Federal environmental statutes and regulations, in addition to all applicable state and local requirements. DOE is committed to fully complying with all applicable environmental statutes, regulatory requirements, and Executive and internal orders. Table 5.3–2 lists selected DOE ES&H orders which apply to all sites, but which may affect each site differently.

DOE has entered into agreements with regulatory agencies on behalf of all of the DOE facilities being considered in this Programmatic Environmental Impact Statement (PEIS). These agreements normally establish a schedule for achieving full compliance at these DOE facilities. Table 5.3–3 lists those DOE environmental agreements with Federal and state regulatory agencies that have substantive provisions in effect. Appendix section A.1 summarizes the applicability and provides more detail on the environmental regulatory compliance agreements and consent orders still in effect at each of the nuclear facilities. These agreements and consent orders are generally available from the regulatory agency that is a party to the agreement, normally the state environmental department or EPA region, and also at the local DOE information resource center or reading room. Table 5.3–4 lists the potential requirements imposed by the major state environmental statutes and regulations applicable to this PEIS. These requirements apply to Federal activities within the jurisdiction of the enforcing authority. Just as table 5.3–1 identifies requirements based on Federal laws, table 5.3–4 identifies the permits, approvals, and consultations generally required to site, construct, or operate tritium supply and recycling facilities in accordance with state statutes and regulations.

## 5.4 Federal and State Environmental Enforcement

Under various Federal environmental statutes (table 5.3–1), the EPA may delegate the implementation and execution of the laws' various provisions to states with approved programs that are at least as stringent as the minimum Federal requirements contained in the laws and EPA regulations. Table 5.3–4 lists many of the states' laws and regulations, including provisions that are more strigent than the minimum requirements. In addition, the *Federal Facility Compliance Act* of 1992 waives sovereign immunity from the enforcement of *Resource Conservation and Recovery Act* (RCRA) at Federal facilities and thereby gives states the authority to assess fines and penalties under certain conditions. It further requires DOE to develop plans and enter into agreements with states as to specific management actions for particular mixed waste streams. Such agreements could have a direct effect on the wastes generated as a result of the implementation of the proposed action, yet such an effect cannot be determined until such time as these agreements are

approved according to the terms of the *Federal Facility Compliance Act.*

Some environmental regulatory programs are enforced through review, approval, and permitting requirements that attempt to minimize the negative impacts from releases to the environment from potential pollution sources by limiting activities to established standards. Federal and state agencies share environmental regulatory authority over DOE facility operations when Federal legislation delegates permitting or review authority to qualifying states. Some examples are: the National Emission Standards for Hazardous Air Pollutants (NESHAP) and the Prevention of Significant Deterioration under the *Clean Air Act* (CAA); the Water Quality Standards and the National Pollutant Discharge Elimination System (NPDES) under the *Clean Water Act* (CWA); the Hazardous Waste Programs under RCRA; and the Drinking Water and Underground Injection Control Programs under the *Safe Drinking Water Act* (SDWA). When Federal legislation allows delegation of enforcement authority, states must set standards equal to or more stringent than those required by Federal law to obtain such authority. Where the Federal regulatory agency has delegated its authority, the state or local regulations set the governing standards. However, when Federal legislation does not provide for delegation of enforcement authority to the states, e.g., the *Toxic Substances Control Act* (TSCA), the standards are administered and enforced solely by the Federal government.

## 5.5 Compliance with Occupational Safety and Health Requirements

The health and safety of all workers associated with the tritium supply and recycling facilities is a primary consideration in the programmatic decision resulting from this PEIS. A comprehensive nuclear and occupational safety and health initiative was announced by the Secretary on May 5, 1993 entailing closer consultation with the Occupational Safety and Health Administration (OSHA) regarding regulation of worker safety and health at DOE contractor-operated facilities. Regulation of worker health and safety at DOE contractor-operated facilities will gradually shift from DOE to OSHA. The *Occupational Safety and Health Act* of 1970, (Public Law 91-596) establishes Federal requirements for assuring occupational safety and health protection for employees. DOE facilities also comply with the *Emergency Planning and Community Right-To-Know Act,* (42 USC §11001) which requires facilities to report the release of extremely hazardous substances and other specified chemicals; provide material safety data sheets or lists thereof; and provide estimates of the amounts of hazardous chemicals on-site. The reporting and emergency preparedness requirements are designed to protect both individuals and communities.

*Workplace Safety and Accidents.* Operations at all DOE sites expose workers to occupational hazards during the normal conduct of their work activities. Occupational safety and health training is provided for all employees at DOE facilities and includes specialized job safety and health training appropriate to the work performed. Such training also includes informing employees of their rights and responsibilities under the *Occupational Safety and Health Act* of 1970, Executive Order 12196, which established OSHA Federal Agency Standards, 29 CFR 1960- *The OSHA Federal Agency Standards*-which describes the safety and health programs that Federal agencies must establish and implement under Executive Order 12196, and DOE Order 3790.1B (*Federal Employee Occupational Safety and Health Program).* DOE provides implementation guidance in DOE Order 3790.1B, including the requirements and guidelines for the DOE Federal Employee Industrial Hygiene Program. DOE policy is to:

- Provide places and conditions of employment that are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm.
- Assure that employees and employee representatives shall have the opportunity to participate in the Federal Employee Occupational Safety and Health Program.
- Establish programs in safety and health training for all levels of Federal employees.
- Consider the 29 CFR 1960 (*OSHA Standards For Federal Agencies*) requirements to be the minimum standards for DOE employees.

DOE contractor operations at each site expose workers to hazardous constituents. DOE orders require that site operations have programs for protection of workers. DOE Orders 5480.11, *Radiation Protection for Occupational Workers,* and 5483.1A, *Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities,* establish procedures for protection of workers against radiological and hazardous materials, respectively. DOE Order 5000.3B, *Occurrence Reporting and Processing of Operations Information,* provides for reporting and guides appropriate corrective action(s) and follow-up should an exposure occur.

DOE Order 5440.1E, *National Environmental Policy Act Compliance Program;* DOE Order 5480.1B, *Environment Safety and Health Program for Department of Energy Operations;* DOE Order 5480.23, *Nuclear Safety Analysis Reports;* DOE Order 5481.1B, *Safety Analysis and Review System;* and DOE Order 6430.1A, *General Design Criteria,* provide the basis for review of all planned and existing construction and operation for the potential for accidents and the assessment of the associated human health and environmental consequences, should an accident occur. The results of these reviews are used as the basis for determining the need for controls or other mitigative actions to eliminate or greatly reduce the potential for, and consequences of, an accident. These reviews are required before authorization of construction or start of operation. These reviews also involve the identification of hazards and an analysis of normal, abnormal, and accident conditions. This analysis includes consideration of natural and man-made external events including fires, floods, tornadoes, earthquakes, other severe weather events, human errors, and explosions. The sites associated with the tritium supply and recycling proposal have complied with applicable DOE orders.

In accordance with DOE Order 5500.1B, *Emergency Management System,* emergency response planning and training are provided to mitigate the consequences of potential accidents. Additionally, should an accident occur, the incident would be reported in accordance with DOE Orders 5000.3B, *Occurrence Reporting and Processing of Operations Information,* and 5400.4, *Comprehensive Environmental Response, Compensation, and Liability Act Requirements.* The reports would also include appropriate corrective action(s) and follow-up.

*Consequences of the Tritium Supply and Recycling Proposal on Candidate Site Workplace Safety and Accidents.* Construction and operation of tritium supply and recycling facilities at potential candidate sites would result in increased exposure of site workers to industrial-type work hazards and accidents. In addition, levels of risk to workers in new construction increases in relation to the amount of new construction required for the tritium supply and recycling facilities. Based on the length of construction periods for the candidate tritium supply technologies, the Modular High Temperature Gas-Cooled Reactor (MHTGR) (9 years) and the Heavy Water Reactor (HWR) (8 years) would have the largest risk and the Accelerator Production of Tritium (APT) (5 years) the least construction accident risk. Based on technology designs, the MHTGR and APT would be expected to have increased worker safety and accident risks during construction because of the deep below ground excavation required for reactor vessel and accelerator tunnel construction. Table 5.5–1 shows the relative risk of fatalities due to construction by technology. Before implementation of the tritium supply and recycling proposal at any site, however, notification would be made to the site's environmental, safety, and health staff that a new process or facility is being planned, or that an existing process is being considered for change or modification to allow the impact of the anticipated change on the work environment to be evaluated.

Appropriate measures would be implemented to minimize work hazards and accidents based on this early evaluation. Once operational, as part of the Occupational Safety and Health Program at each site, ongoing surveillance of the new or modified processes or activities would be performed to identify potential health hazards. If potential health hazards are identified, a hazard evaluation would be conducted to determine the extent of the hazard and if required, the recommended control measures. Where feasible, engineering controls would be used to protect worker health and safety. Administrative controls and personal protective equipment would supplement engineering controls as appropriate.

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 1 of 5]

| Resource Category | Statute/Regulation/Order | Citation | Responsible Agency | PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications |
|---|---|---|---|---|
| Air Resources | Clean Air Act (CAA), as amended | 42 USC §§7401 et seq. | EPA | Requires sources to meet standards and obtain permits to satisfy: National Ambient Air Quality Standards (NAAQS), State Implementation Plans, Standards of Performance for New Stationary Sources, National Emission Standards for Hazardous Air Pollutants (NESHAP), and Prevention of Significant Deterioration. |
| | National Ambient Air Quality Standards/State Implementation Plans | 42 USC §§7409 et seq. | EPA | Requires compliance with primary and secondary ambient air quality standards governing $SO_2$, $NO_x$, CO, $O_3$, Pb, and $PM_{10}$ and emission limits/reduction measures as designated in each state's State Implementation Plan. |
| | Standards of Performance for New Stationary Sources | 42 USC §7411 | EPA | Establishes control/emission standards and recordkeeping requirements for new or modified sources specifically addressed by a standard. |
| | National Emission Standards for Hazardous Air Pollutants | 42 USC §7412 | EPA | Requires sources to comply with emission levels of carcinogenic or mutagenic pollutants; may require a preconstruction approval, depending on the process being considered and the level of emissions that will result from the new or modified source. |
| | Prevention of Significant Deterioration | 42 USC §§7470 et seq. | EPA | Applies to areas that are in compliance with NAAQS. Requires comprehensive preconstruction review and the application of Best Available Control Technology to major stationary sources (emissions of 100 tons/year) and major modifications; requires a preconstruction review of air quality impacts and the issuance of a construction permit from the responsible state agency setting forth emission limitations to protect the Prevention of Significant Deterioration increment. |
| | Noise Control Act of 1972 | 42 USC §§4901 et seq. | EPA | Requires facilities to maintain noise levels that do not jeopardize the health and safety of the public. |
| Water Resources | Clean Water Act (CWA) | 33 USC §§1251 et seq. | EPA | Requires EPA or state-issued permits and compliance with provisions of permits regarding discharge of effluents to surface waters. |
| | National Pollutant Discharge Elimination System (NPDES) (section 402 of CWA) | 33 USC §1342 | EPA | Requires permit to discharge effluents (pollutants) to surface waters and stormwaters; permit modifications are required if discharge effluents are altered. |
| | Dredged or Fill Material - (section 404 of CWA)/Rivers and Harbors Appropriations Act of 1899 | 33 USC §1344/ 33 USC §§401 et seq. | U.S. Army Corps of Engineers | Requires permits to authorize the discharge of dredged or fill material into navigable waters or wetlands and to authorize certain structures or work in or affecting navigable waters. |

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 2 of 5]

| Resource Category | Statute/Regulation/Order | Citation | Responsible Agency | PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications |
|---|---|---|---|---|
| Water Resources (continued) | Wild and Scenic Rivers Act | 16 USC §§1271 et seq. | Fish and Wildlife Service (USFWS), Bureau of Land Management, Forest Service, National Park Service | Consultation required before construction of any new Federal project associated with a river designated as wild and scenic or under study in order to minimize and mitigate any adverse effects on the physical and biological properties of the river. |
| | Safe Drinking Water Act (SDWA) | 42 USC §§300f et seq. | EPA | Requires permits for construction/operation of underground injection wells and subsequent discharging of effluents to ground aquifers. |
| | Executive Order 11988: Floodplain Management | 3 CFR, 1977 Comp., p. 117 | Water Resources Council, Federal Emergency Management Agency, Council on Environmental Quality (CEQ) | Requires consultation if project impacts a floodplain. |
| | Executive Order 11990: Protection of Wetlands | 3 CFR, 1977 Comp., p. 121 | U.S. Army Corps of Engineers/USFWS | Requires Federal agencies to avoid the long and short term adverse impacts associated with the destruction or modification of wetlands. |
| | Compliance with Floodplain/Wetlands Environmental Review Requirements | 10 CFR 1022 | DOE | Requires DOE to comply with all applicable floodplain/wetlands environmental review requirements. |
| Hazardous Wastes and Soil Resources | Resource Conservation and Recovery Act (RCRA)/Hazardous and Solid Waste Amendments of 1984 | 42 USC §§6901 et seq./PL 98-616 | EPA | Requires notification and permits for operations involving hazardous waste treatment, storage, or disposal facilities; changes to site hazardous waste operations could require amendments to RCRA hazardous waste permits involving public hearings. |
| | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)/Superfund Amendments and Reauthorization Act of 1986 (SARA) | 42 USC §§9601 et seq./PL 99-499 | EPA | Requires cleanup and notification if there is a release or threatened release of a hazardous substance; requires DOE to enter into Interagency Agreements with EPA and state to control the cleanup of each DOE site on the National Priorities List (NPL). |

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 3 of 5]

| Resource Category | Statute/Regulation/Order | Citation | Responsible Agency | PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications |
|---|---|---|---|---|
| Hazardous Wastes and Soil Resources (continued) | Community Environmental Response Facilitation Act | PL 102-426 | EPA | Amends CERCLA (40 CFR 300) to establish a process for identifying, prior to the termination of Federal activities, property that does not contain contamination. Requires prompt identification of parcels that will not require remediation to facilitate the transfer of such property for economic redevelopment purposes. |
| | Farmland Protection Policy Act of 1981 | 7 USC §§4201 et seq. | Soil Conservation Service | DOE shall avoid any adverse effects to prime and unique farmlands. |
| | Federal Facility Compliance Act of 1992 | 42 USC §6961 | States | Waivers of sovereign immunity for Federal facilities under RCRA and requires DOE to develop plans and enter into agreements with states as to specific management actions for specific mixed waste streams. |
| Biotic Resources | Fish and Wildlife Coordination Act | 16 USC §§661 et seq. | USFWS | Requires consultation on the possible effects on wildlife if there is construction, modification, or control of bodies of water in excess of 10 acres in surface area. |
| | Bald and Golden Eagle Protection Act | 16 USC §§668 et seq. | USFWS | Consultations should be conducted to determine if any protected birds are found to inhabit the area. If so, DOE must obtain a permit prior to moving any nests due to construction or operation of tritium supply and recycling facilities. |
| | Migratory Bird Treaty Act | 16 USC §§703 et seq. | USFWS | Requires consultation to determine if there are any impacts on migrating bird populations due to construction or operation of tritium supply and recycling facilities. If so, DOE will develop mitigation measures to avoid adverse effects. |
| | Wilderness Act of 1964 | 16 USC §§1131 et seq. | Department of Commerce and DOI | DOE shall consult with DOC/DOI and minimize impact. |
| | Wild Free-Roaming Horses and Burros Act of 1971 | 16 USC §§1331 et seq. | DOI | DOE shall consult with DOI and minimize impact. |
| | Endangered Species Act of 1973 | 16 USC §§1531 et seq. | USFWS/National Marine Fisheries Service | Requires consultation to identify endangered or threatened species and their habitats, assess DOE impacts thereon, obtain necessary biological opinions and, if necessary, develop mitigation measures to reduce or eliminate adverse effects of construction or operation. |
| Cultural Resources | National Historic Preservation Act of 1966, as amended | 16 USC §§470 et seq. | President's Advisory Council on Historic Preservation | DOE shall consult with the State Historic Preservation Office (SHPO) prior to construction to ensure that no historical properties will be affected. |
| | Archaeological and Historical Preservation Act of 1974 | 16 USC §§469 et seq. | DOI | DOE shall obtain authorization for any disturbance of archaeological resources. |
| | Archaeological Resources Protection Act of 1979 | 16 USC §§470aa et seq. | DOI | DOE shall obtain authorization for any excavation or removal of archaeological resources. |

**TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 4 of 5]**

| Resource Category | Statute/Regulation/Order | Citation | Responsible Agency | PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications |
|---|---|---|---|---|
| Cultural Resources (continued) | American Indian Religious Freedom Act of 1978 | 42 USC §1996 | DOI | DOE shall consult with local Native American Indian tribes prior to construction to ensure that their religious customs, traditions, and freedoms are preserved. |
| | Native American Graves Protection and Repatriation Act of 1990 | 25 USC §3001 | DOI | DOE shall consult with local Native American Indian tribes prior to construction to guarantee that no Native American graves are disturbed. |
| | Executive Order 11593: Protection and Enhancement of the Cultural Environment | 3 CFR 154, 1971-1975 Comp., p. 559 | DOI | DOE shall aid in the preservation of historic and archaeological data that may be lost during construction activities. |
| Worker Safety and Health | Occupational Safety and Health Act (OSHA) | 5 USC §5108 | OSHA | Agencies shall comply with all applicable worker safety and health legislation (including guidelines of 29 CFR 1960) and prepare, or have available, Material Safety Data Sheets. |
| | Hazard Communication Standard | 29 CFR 1910.1200 | OSHA | DOE shall ensure that workers are informed of, and trained to handle, all chemical hazards in the DOE workplace. |
| Other | Atomic Energy Act of 1954 | 42 USC §2011 | DOE | DOE shall follow its own standards and procedures to ensure the safe operation of its facilities. |
| | National Environmental Policy Act (NEPA) | 42 USC §§4321 et seq. | CEQ | DOE shall comply with NEPA implementing procedures in accordance with 10 CFR 1021. |
| | Uranium Mill Tailings Radiation Control Act of 1978 | 42 USC §§7901 et seq. | EPA | DOE shall enforce and implement health and environmental standards and acquire licenses when required. |
| | Toxic Substances Control Act (TSCA) | 15 USC §§2601 et seq. | EPA | DOE shall comply with inventory reporting requirements and chemical control provisions of TSCA to protect the public from the risks of exposure to chemicals; TSCA imposes strict limitations on use and disposal of PCB-contaminated equipment. |
| | Hazardous Materials Transport Action Act | 49 USC §§1801 et seq. | DOT | DOE shall comply with the requirements governing hazardous materials and waste transportation. |
| | Hazardous Materials Transportation Uniform Safety Act of 1990 | 49 USC §1801 | DOT | Restricts shippers of highway route-controlled quantities of radioactive materials to use only permitted carriers. |
| | Emergency Planning and Community Right-To-Know Act of 1986 | 42 USC §§11001 et seq. | EPA | Requires the development of emergency response plans and reporting requirements for chemical spills and other emergency release, and imposes right-to-know reporting requirements covering storage and use of chemicals which are reported in toxic chemical release forms. |

TABLE 5.3–1.—*Federal Environmental Statutes, Regulations, and Orders* [Page 5 of 5]

| Resource Category | Statute/Regulation/Order | Citation | Responsible Agency | PEIS-Level Potential Applicability: Permits, Approvals, Consultations, and Notifications |
|---|---|---|---|---|
| Other (continued) | Pollution Prevention Act of 1990 | 42 USC 11001-11050 | EPA | Establishes a national policy that pollution should be reduced at the source and requires a toxic chemical source reduction and recycling report for an owner or operator of a facility required to file an annual toxic chemical release form under section 313 of SARA. |
| | Executive Order 12843: Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances | April 21, 1993 | EPA | Requires Federal agencies to minimize procurement of ozone depleting substances and conform their practices to comply with Title VI of CAA Amendments reference stratospheric ozone protection and to recognize the increasingly limited availability of Class I substances until final phaseout. |
| | Executive Order 12856: Federal Compliance with Right-To-Know Laws and Pollution Prevention Requirements | August 3, 1993 | EPA | Requires Federal agencies to achieve 50% reduction of agency's total releases of toxic chemicals to the environment and offsite transfers, to prepare a written facility pollution prevention plan not later than 1995, and to publicly report toxic chemicals entering any waste stream from Federal facilities, including any releases to the environment, and to improve local emergency planning, response and accident notification. |
| | Executive Order 12873: Federal Acquisition, Recycling, and Waste Prevention | October 20, 1993 | EPA | Requires Federal agencies to develop affirmative procurement policies and establishes a shared responsibility between the system program manager and the recycling community to effect use of recycled items for procurement. |
| | Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations | February 11, 1994 | EPA | Requires Federal agencies to identify and address as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. |
| | Executive Order 12088: Federal Compliance with Pollution Control Standards | 3 CFR, 1978 Comp., p. 243 | Office of Management and Budget | Requires Federal agency landlords to submit to OMB an annual plan for the control of environmental pollution and to consult with EPA and state agencies regarding the best techniques and methods. |
| | Executive Order 11514: Protection and Enhancement of Environmental Quality | 3 CFR, 1966-1970 Comp., p. 902 | CEQ | Requires Federal agencies to demonstrate leadership in achieving the environmental quality goals of NEPA; provides for DOE consultation with appropriate Federal, state, and local agencies in carrying out their activities as they affect the environment. |
| | Nuclear Waste Policy Act of 1982 | 42 USC §§10101 et seq. | EPA | DOE shall dispose of radioactive waste per standards of 40 CFR 191. |
| | Low-Level Radioactive Waste Policy Act | 42 USC §§2021b-2021d | NRC | DOE shall dispose of LLW per compacts of the states in which it operates. |

TABLE 5.3–2.—***Selected Department of Energy Environment, Safety, and Health Orders***

| DOE Order | Order Title |
|---|---|
| 1540.2 | Hazardous Material Packaging for Transport-Administrative Procedures |
| 1540.3A | Base Technology for Radioactive Material Transportation Packaging Systems |
| 3790.1B | Federal Employee Occupational Safety and Health Program |
| 5000.3B | Occurrence Reporting and Processing of Operations Information |
| 5400.1 | General Environmental Protection Program |
| 5400.2A | Environmental Compliance Issue Coordination |
| 5400.4 | Comprehensive Environmental Response, Compensation, and Liability Act Requirements |
| 5400.5 | Radiation Protection of the Public and the Environment |
| 5440.1E | National Environmental Policy Act Compliance Program |
| 5480.1B | Environment, Safety, and Health Program for Department of Energy Operations |
| 5480.3 | Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Waste |
| 5480.4 | Environmental Protection, Safety, and Health Protection Standards |
| 5480.6 | Safety of Department of Energy-Owned Nuclear Reactors |
| 5480.7A | Fire Protection |
| 5480.9A | Construction Project Safety and Health Management |
| 5480.10 | Contractor Industrial Hygiene Program |
| 5480.11 | Radiation Protection for Occupational Workers |
| 5480.19 | Conduct of Operations Requirements for DOE Facilities |
| 5480.21 | Unreviewed Safety Questions |
| 5480.22 | Technical Safety Requirements |
| 5480.23 | Nuclear Safety Analysis Reports |
| 5480.24 | Nuclear Criticality Safety |
| 5481.1B | Safety Analysis and Review System |
| 5482.1B | Environment, Safety, and Health Appraisal Program |
| 5483.1A | Occupational Safety and Health Program for DOE Contractor Employees at Government-Owned Contractor-Operated Facilities |
| 5484.1 | Environmental Protection, Safety, and Health Protection Information Reporting Requirements |
| 5500.1B | Emergency Management System |
| 5500.3A | Planning and Preparedness for Operational Emergencies |
| 5530.1A | Accident Response Group |
| 5530.4 | Aerial Measuring System |
| 5630.11B | Safeguards and Security Program |
| 5630.12A | Safeguards and Security Inspection and Assessment Program |
| 5632.1C | Protection and Control of Safeguards and Security Interests |
| 5700.6C | Quality Assurance |
| 5820.2A | Radioactive Waste Management |
| 6430.1A | General Design Criteria |

TABLE 5.3–3.—*Department of Energy Agreements with Federal and State Environmental Regulatory Agencies*

| Facility | Resource Category | Parties (Agency/State) | Scope of Agreement | Effective Date |
|---|---|---|---|---|
| Idaho National Engineering Laboratory | Air | DOE/ID | CAA-Consent Order (Permit to construct) | 02/11/92 |
| | Water | DOE/ID | RCRA-Consent Order on percolation ponds | 10/07/92 |
| | Soil | DOE/EPA/ID | CERCLA/RCRA-Federal Facility Agreement & Consent Order | 12/09/91 |
| | Soil | DOE/ID/EPA | RCRA-Consent Order | 04/03/92 |
| Nevada Test Site | Soil | DOE/NV | RCRA-Settlement Agreement-TRU mixed waste | 07/23/92 |
| | Cultural | DOE/NV | Programmatic Agreement-Archaeological and Historic Preservation activities | 05/08/93 |
| Oak Ridge Reservation | Air | DOE/EPA | CAA-Federal Facility Compliance Agreement, Radionuclide NESHAP | 05/26/92 |
| | Soil | DOE/EPA/TN | CERCLA-Federal Facility Agreement | 01/01/92 |
| | Soil | DOE/EPA | RCRA-Federal Facility Compliance Agreement for storage of mixed waste subject to Land Disposal Restrictions | 06/12/92 |
| Pantex Plant | Soil | DOE/EPA | RCRA-Section 3008 (h) Administrative Order on Consent | 12/10/90 |
| Savannah River Site | Air | DOE/EPA | CAA-Federal Facility Compliance Agreement for Radionuclide NESHAP | 10/31/91 |
| | Water | DOE/SC | CWA-Consent Order 84-4-W, Thermal discharge limitations, with amendment | 01/03/84, 08/31/87 |
| | Water | DOE/SC | CWA-Settlement Agreement 90-13-W, Construction of a wastewater treatment facility | 02/27/90, 01/16/91 |
| | Water | DOE/SC | CWA-Settlement Agreement 90-25-W, Thermal mitigation of minor discharges | 06/05/90 |
| | Water | DOE/SC | CWA-Settlement Agreement 90-26-W, Fish kill mitigation | 06/05/90 |
| | Water | DOE/SC | CWA-Settlement Agreement 91-44-W, NPDES | 07/31/91 |
| | Soil | DOE/SC | RCRA-Settlement Agreement 87-52-SW with amendment, Part B application deficiencies; groundwater monitoring | 11/12/87, 05/10/91 |
| | Soil | DOE/SC | RCRA/SC Hazardous Waste Management Act-Consent Decree - Civil Action | 05/26/88, 08/03/89 |
| | Soil | DOE/EPA | RCRA-Federal Facility Compliance Agreement for Land Disposal Restrictions, with amendment 1, Docket No. 91-01-FFR | 03/13/91, 04/24/92 |
| | Soil | DOE/SC | RCRA-Settlement Agreement 91-51-SW, Solvent rag violations | 08/26/91 |
| | Soil | DOE/EPA/SC | CERCLA/RCRA-Federal Facility Agreement | 01/15/93 |
| | Cultural | DOE/SHPO ACHP | Programmatic Memorandum of Agreement-Management of archaeological sites | 08/24/90 |

**TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 1 of 5]**

| Resource Category | Legislation | Citation | Responsible Agency | Potential Applicability/Permits |
|---|---|---|---|---|
| **Idaho National Engineering Laboratory, Idaho** | | | | |
| Air Resources | Idaho Environmental Protection and Health Act | ID Code, Title 39, Chapter 101 | ID Department of Health and Welfare | Permit required prior to construction or modification of an air contaminant source. |
| | Idaho Department of Health and Welfare Rules | ID Code, Title 39, Chapter 1 | ID Department of Health and Welfare | Permit required prior to construction or modification of an air contaminant source. |
| Water Resources | Idaho Wastewater-Land Application Permit Regulations | ID Rules/Regs., Title 1, Chapter 17 | ID Department of Health and Welfare | Permit required prior to construction or modification of a water discharge source. |
| | Idaho Water Pollution Control Act | ID Code, Title 39, Chapter 36 | ID Department of Health and Welfare | Permit required prior to construction or modification of a water discharge source. |
| | Idaho Water Quality Standards | ID Rules/Regs., Title 1, Chapter 2 | ID Department of Water Resources, Resource Administration Division | Permit required prior to the construction or operation of a wastewater injection well. |
| | Idaho Stream Channel Protection Act | ID Code, Title 42, Chapter 38 | ID Department of Water Resources | Permit required prior to dredge or fill of any stream. |
| | Idaho Lake Protection Act | ID Code, Section 58-142 et seq. | ID Department of Lands | Permit required prior to dredge or fill of any lake. |
| Hazardous Wastes and Soil Resources | Idaho Hazardous Waste Management Act | ID Code, Title 39, Chapter 44 | ID Department of Health and Welfare | Permit required prior to construction or modification of a hazardous waste disposal facility. |
| | Idaho Hazardous Waste Management Regulations | ID Rules/Regs., Title 1, Chapter 5 | ID Department of Health and Welfare | Permit required prior to construction or modification of a hazardous waste disposal facility. |
| Biotic Resources | No state-level legislation identified | | | |
| Cultural Resources | Idaho Historic Preservation Act | ID Code, Title 67, Chapter 46 | ID Historic Preservation Commission | Consult with responsible local governing body. |
| Worker Safety and Health | No state-level legislation identified | | | |

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 2 of 5]

| Resource Category | Legislation | Citation | Responsible Agency | Potential Applicability/Permits |
|---|---|---|---|---|
| **Nevada Test Site, Nevada** | | | | |
| Air Resources | Nevada Air Pollution Control Law | NV Statutes, Title 40 | NV State Environmental Commission | Permit required prior to construction or modification of an air contaminant source. |
| | Nevada Air Quality Regulations | NV Admin. Code, Chapter 445 | NV State Environmental Commission | Permit required prior to construction or modification of an air contaminant source. |
| Water Resources | Nevada Water Pollution Control Law | NV Statutes, Title 40, Chapter 445 | NV Department of Environmental Protection | Permit required prior to construction or modification of a water discharge source. |
| | Nevada Water Pollution Control Regulations | NV Admin. Code, Chapter 445 | NV Department of Environmental Protection | Permit required prior to construction or modification of a water discharge source. |
| Hazardous Wastes and Soil Resources | Nevada Underground Storage Tank Rules | NV Admin. Code, Chapter 459 | NV Department of Environmental Protection | Permit required prior to construction or modification of an underground storage tank. |
| | Nevada Solid Waste Disposal Law | NV Statutes, Title 40, Chapter 444 | NV Department of Environmental Protection | Permit required prior to construction or modification of a solid waste disposal facility. |
| | Nevada Solid Waste Disposal Regulations | NV Admin. Code, Chapter 44 | NV Department of Environmental Protection | Permit required prior to construction or modification of a solid waste disposal facility; permit for septage hauling may be required. |
| | Nevada Hazardous Waste Disposal Law | NV Statutes, Title 40, Chapter 459 | NV Department of Environmental Protection | Permit required prior to construction or modification of a hazardous waste disposal facility. |
| | Nevada Hazardous Waste Facility Regulations | NV Admin. Code, Chapter 444 | NV Department of Environmental Protection | Permit required prior to construction or modification of a hazardous waste disposal facility. |
| Biotic Resources | Nevada Non-Game Species Act | NV Admin. Code, Title 45, Chapter 503 | NV Department of Wildlife | Consult with NV Department of Wildlife and minimize impact. |
| Cultural Resources | Historic Preservation and Archaeology Regulations | NV Statutes, Title 26, Chapter 381-383 | NV Advisory Board for Historic Preservation and Archaeology | Permit required prior to the investigation, exploration, or excavation of an historic or prehistoric site. |
| Worker Safety and Health | No state-level legislation identified | | | |

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 3 of 5]

| Resource Category | Legislation | Citation | Responsible Agency | Potential Applicability/Permits |
|---|---|---|---|---|
| **Oak Ridge Reservation, Tennessee** | | | | |
| Air Resources | Tennessee Air Pollution Control Regulations | TN Rules, Division of Air Pollution | TN Air Pollution Control Board | Permit required to construct, modify, or operate an air contaminant source; sets fugitive dust requirements. |
| Water Resources | Tennessee Water Quality Control Act | TN Code, Title 69, Chapter 3 | TN Water Quality Control Board | Authority to issue new or modify existing NPDES permits required for a water discharge source. |
| Hazardous Wastes and Soil Resources | Tennessee Underground Storage Tank Program Regulations | TN Rules, Chapter 1200-1-15 | TN Division of UST Programs | Permit required prior to construction or modification of an underground storage tank. |
| | Tennessee Hazardous Waste Management Act | TN Code, Title 68, Chapter 46 | TN Division of Solid Waste Management | Permit required to construct, modify, or operate a hazardous waste treatment, storage, or disposal facility. |
| | Tennessee Solid Waste Processing and Disposal Regulations | TN Rules, Chapter 1200-1-7 | TN Division of Solid Waste Management | Permit required to construct or operate a solid waste processing or disposal facility. |
| Biotic Resources | Tennessee State Executive Order on Wetlands | TN State Executive Order | TN Division of Water Quality Control | Consultation with responsible agency. |
| | Tennessee Threatened Wildlife Species Conservation Act of 1974 | TN Code, Title 70, Chapter 8 | TN Wildlife Resources Agency | Consultation with responsible agency. |
| | Tennessee Rare Plant Protection and Conservation Act of 1985 | TN Code, Title 70, Chapter 8-301 et seq. | TN Wildlife Resources Agency | Consultation with responsible agency. |
| | Tennessee Water Quality Control Act | TN Code, Title 69, Chapter 3 | TN Division of Water Quality Control | Permit required prior to alteration of a wetland. |
| Cultural Resources | Tennessee Desecration of Venerated Objects | TN Code, Title 39, Chapter 17-311 | TN Historical Commission | Forbids a person to offend or intentionally desecrate venerated objects including a place of worship or burial. |
| | Tennessee Abuse of Corpse | TN Code, Title 39, Chapter 17-312 | TN Historical Commission | Forbids a person from disinterring a corpse that has been buried or otherwise interred. |
| | Native American Indian Cemetery Removal and Reburial | TN Comp. Rules and Regulations, Chapter 400-9-1 | TN Historical Commission | Requires notification if Native American Indian remains are uncovered. |
| | Tennessee Protective Easements | TN Code, Title 11, Chapter 15-101 | TN State Government | Grants power to the state to restrict construction on land deemed as a "protective" easement. |
| Worker Safety and Health | No state-level legislation identified | | | |

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 4 of 5]

| Resource Category | Legislation | Citation | Responsible Agency | Potential Applicability/Permits |
|---|---|---|---|---|
| **Pantex Plant, Texas** | | | | |
| Air Resources | Texas Air Pollution Control Regulations | TX Admin. Code, Title 30, Chapter 101-125, 305 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of an air contaminant source. |
| Water Resources | Texas Water Quality Standards | TX Admin. Code, Title 30, Chapter 305, 308-325 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of a water discharge source. |
| | Texas Consolidated Permit Rules | TX Admin. Code, Title 30 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of a water discharge source. |
| | Texas Water Quality Acts | TX Code, Title 30, Chapter 290 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of a water discharge source affecting a public water supply. |
| Hazardous Wastes and Soil Resources | Texas Underground Storage Tanks Rules | TX Admin. Code, Title 30, Chapter 334 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of an underground storage tank. |
| | Texas Solid Waste Management Regulations | TX Admin. Code, Title 30, Chapter 305, 335 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of a solid waste disposal facility. |
| | Texas Solid Waste Disposal Act | TX Statutes, Article 4477-7 | TX Natural Resource Conservation Commission (effective 9/1/93) | Permit required prior to construction or modification of a solid waste disposal facility. |
| Biotic Resources | Texas Parks and Wildlife Regulations | TX Parks and Wildlife Code, Chapters 67, 68, & 88 | TX Parks and Wildlife Department | Permit required by anyone who possesses, takes, or transports endangered, threatened, or protected plants or animals. |
| Cultural Resources | Antiquities Code of Texas | TX Statutes, Volume 17, Article 6145 | TX State Historical Survey Committee | Permit required for the examination or excavation of sites and the collection or removal of objects of antiquity. |
| Worker Safety and Health | No state-level legislation identified | | | |

TABLE 5.3–4.—*State Environmental Statutes, Regulations, and Orders* [Page 5 of 5]

| Resource Category | Legislation | Citation | Responsible Agency | Potential Applicability/Permits |
|---|---|---|---|---|
| **Savannah River Site, South Carolina** | | | | |
| Air Resources | South Carolina Pollution Control Act/South Carolina Air Pollution Control Regulations and Standards | SC Code, Title 48, Chapter 1 | SC Dept. of Health and Environmental Control | Permit required prior to construction or modification of an air contaminant source. |
| | Augusta-Aiken Air Quality Control Region | 40 CFR 81.114 | SC and GA | Requires SRS and surrounding communities in the 2-state region to attain NAAQS. |
| | South Carolina Atomic Energy & Radiation Control Act | SC Code, Title 13, Chapter 7 | SCDHEC | Establishes standards for radioactive air emissions. |
| Water Resources | South Carolina Pollution Control Act | SC Code, Title 48, Chapter 1 | SCDHEC | Permit required prior to construction or modification of a water discharge source. |
| | South Carolina Water Quality Standards | SC Code, Title 61, Chapter 68 | SCDHEC | Permit required prior to construction or modification of a water discharge source. |
| | South Carolina Safe Drinking Water Act | SC Code, Title 44, Chapter 55 | SCDHEC | Establishes drinking water standards. |
| Hazardous Wastes and Soil Resources | South Carolina Underground Storage Tanks Act | SC Code, Title 44, Chapter 2 | SCDHEC | Permit required prior to construction or modification of an underground storage tank. |
| | South Carolina Solid Waste Regulations | SC Code, Title 61, Chapter 60 | SCDHEC | Permit required to store, collect, dispose, or transport solid wastes. |
| | South Carolina Industrial Solid Waste Disposal Site Regulations | SC Code, Title 61, Chapter 66 | SC Pollution Control Authority | Permit required for industrial solid waste disposal systems. |
| | South Carolina Hazardous Waste Management Act | SC Code, Title 44, Chapter 56 | SCDHEC | Permit required to operate, construct, or modify a hazardous waste treatment, storage, or disposal facility. |
| | South Carolina Solid Waste Management Act | SC Code, Title 44, Chapter 96 | SCDHEC | Establishes standards to treat, store, or dispose of solid waste. |
| Biotic Resources | South Carolina Nongame and Endangered Species Conservation Act | SC Code, Title 50, Chapter 15 | SC Wildlife and Marine Resources Department | Consult with SC Wildlife and Marine Resources Department and minimize impact. |
| Cultural Resources | South Carolina Institute of Archaeology and Anthropology | SC Code, Title 60, Chapter 13-210 | SC State Historic Preservation Office | Consult with SC State Historic Preservation Office and minimize impact. |
| Worker Safety and Health | No state-level legislation identified | | | |

**TABLE 5.5–1.—*Estimated Number of Construction Worker Fatalities by Technology***

| | HWR | MHTGR | ALWR/Large | ALWR/Small | APT | Tritium Recycling |
|---|---|---|---|---|---|---|
| Potential Accidental Worker Deaths[a] | 2.1 | 1.9 | 2.8 | 1.6 | .8 | .2 |

[a] Results are based on the death rates experieced for construction workers in 1993. For the construction industry in general in 1993, the death rate was 22 deaths per 100,000 worker-years.

Source: NSC 1994a.

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# CHAPTER 6: REFERENCES

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B.A., Political Science, 1971, University of Pittsburgh, Pittsburgh, PA
Years of Experience: 17

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Years of Experience: 36

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M.B.A., Management, 1964, Hofstra University, Hempstead, NY
B.S., Electrical Engineering, 1960, Rutgers University, New Brunswick, NJ
Years of Experience: 34

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M.S., Civil Engineering, 1975, Stanford University, Stanford, CA
B.S., Military Science, 1968, U.S. Military Academy, West Point, NY
Years of Experience: 26

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# LIST OF AGENCIES

# List of Agencies

# CHAPTER 8: LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THIS STATEMENT ARE SENT

This chapter lists agencies, organizations, and persons who requested Volumes I and II, and the Executive Summary of the *Tritium Supply and Recycling Draft Programmatic Environmental Impact Statement* (PEIS). Not listed are the many agencies, organizations, and persons who requested the Executive Summary or Volume II appendices.

**Federal-Elected Officials Representing Affected Areas**

*States*: Georgia
Idaho
Nevada
South Carolina
Tennessee
Texas

**Governors Representing Affected Areas**

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Nevada
South Carolina
Tennessee
Texas

**State Elected Officials Representing**

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Nevada
South Carolina
Tennessee
Texas

**Federal-Recognized Indian Tribes**

National Congress of American Indians, DC
Coeur d'Alene Tribal Council, ID
Fort Hall Business Council Sho Ban Tribes, ID
Nez Perce Tribal Executive Committee, ID
Battle Mountain Band Council, NV
Carson Colony Community Council, NV
Dresslerville Community Council, NV
Duckwater Shoshone Indian Tribe, NV
Elko Band Council, NV
Ely Shoshone Indian Tribe, NV
Fort McDermitt Paiute-Shoshone Tribes, NV
Las Vegas Indian Colony, NV
Moapa Paiute Indian Tribe, NV
Pahrump Paiute Indian Tribe, NV
Pyramid Lake Paiute Tribal Council, NV
Shoshone Paiute Business Council, NV
South Fork Band Council, NV
Stewart Community Council, NV
Summit Lake Paiute Council, NV
Council of the Te-Moak Western Shoshone Indians, NV
Walker River Paiute Tribal Council, NV
Wells Indian Colony Band Council, NV
Western Shoshone Elders Council, NV
Western Shoshone National Council, NV
Winnemucca Indian Colony, NV
Yerington Paiute Tribal Council, NV
Yomba Shoshone Indian Tribe, NV
Alabama-Coushatta Tribe of Texas, TX
Kickapoo Traditional Tribe of Texas, TX

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Defense Nuclear Facilities Safety Board
Defense Contract Administration
Federal Energy Regulatory Commission
Food and Drug Administration
General Accounting Office
General Services Administration
Housing and Urban Development
Interstate Commerce Commission
Management Support Systems
Marine Mammal Commission
National Academy of Sciences
National Marine Fisheries Service
National Oceanic & Atmospheric Administration
National Parks and Conservation
National Science Foundation
Office of Solid Waste and Emergency Response
Office of Technology Assessment
Small Business Administration
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U.S. Environmental Protection Agency, Region IX
U.S. Environmental Protection Agency, Region X
U.S. General Accounting Office
U.S. Geological Survey
U.S. National Park Service
U.S. Nuclear Regulatory Commission

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Texas Historical Commission, TX

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# GLOSSARY

# Glossary

# CHAPTER 9: GLOSSARY

**Absorbed dose:** The energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. Expressed in units of radiation absorbed dose or grays, where 1 radiation absorbed dose equals 0.01 gray. Also, see "radiation absorbed dose."

**Accident sequence:** An initiating event followed by system failures or operator errors, which can result in significant core damage, confinement system failure, and/or radionuclide releases.

**Accident severity:** Severity is described as a function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package may be subjected during an accident. Because all forces resulting from accidents can be described in these terms, severity is independent of the actual accident scenario.

**Action Description Memorandum:** A document used in the Department of Energy's National Environmental Policy Act process to facilitate a determination of the appropriate level of National Environmental Policy Act documentation for a proposed action.

**Activation products:** Nuclei, usually radioactive, formed by the bombardment of material with neutrons, protons, or other nuclear particles.

**Acute exposure:** The exposure incurred during and shortly after a radiological release. Generally, the period of acute exposure ends when long-term interdiction is established, as necessary. For convenience, the period of acute exposure is normally assumed to end 1 week after the inception of a radiological accident.

**Acute standard:** A numerical limit on the amount of a particular chemical contaminant that an organism may be exposed to over a short period of time.

**Air Quality Control Region:** An interstate area designated by the Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

**Air quality standards:** The level of pollutants in the air prescribed by regulations that may not be exceeded during a specified time in a defined area.

**Alluvial deposits:** Deposits of earth, sand, gravel, and other materials carried by moving surface water deposited at points of weak water flow.

**Alpha activity:** The emission of alpha particles by fissionable materials (uranium or plutonium).

**Alpha particle:** A positively charged particle, consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

**Alpha wastes:** Wastes containing radioactive isotopes which decay by producing alpha particles.

**Ambient air:** The surrounding atmosphere as it exists around people, plants, and structures.

**American Indian Religious Freedom Act of 1978:** This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

**Anadromous:** Fish that migrate from salt to fresh water to spawn.

**Anisotropic:** Conditions where a physical phenomenon is oriented preferentially in a particular direction or on a particular axis. When the groundwater in a region moves north/south faster than it moves east/west, the groundwater movement is anisotropic.

**Aquatic biota:** The sum total of living organisms within any designated aquatic area.

**Aquifer:** A saturated geologic unit through which significant quantities of water can migrate under natural hydraulic gradients.

**Aquitard:** A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

**Archaeological and Historic Preservation Act of 1974:** This Act is designed to preserve historic and archaeological data that could be destroyed or compromised as the result of Federal construction or other Federally licensed or assisted activities.

**Archaeological Resources Protection Act of 1979:** This Act serves to protect cultural resources on Federally owned lands. It requires a permit for archaeological excavations or removal of any archaeological resources located on public lands or Native American lands. It prohibits interstate or foreign trafficking of cultural resources taken in violation of state or local laws, and requires Federal agencies to develop plans for surveying lands under their control.

**Archaeological sites (resources):** Any location where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

**Artifact:** An object produced or shaped by human workmanship of archaeological or historical interest.

**As low as reasonably achievable:** A concept applied to the quantity of radioactivity released in routine operation of a nuclear system or facility, including "anticipated operational occurrences." It takes into account the state of technology, economics of improvements in relation to benefits to public health and safety, and other societal and economic considerations in relation to the use of nuclear energy in the public interest.

**Atmospheric dispersion:** The process of air pollutants being dispersed in the atmosphere. This occurs by the wind that carries the pollutants away from their source and by turbulent air motion that results from solar heating of the Earth's surface and air movement over rough terrain and surfaces.

**Atomic Energy Act of 1954:** This Act was originally enacted in 1946 and amended in 1954. For the purpose of this Programmatic Environmental Impact Statement "...a program for Government control of the possession, use, and production of atomic energy and special nuclear material whether owned by the Government or others, so directed as to make the maximum contribution to the common defense and security and the national welfare, and to provide continued assurance of the Government's ability to enter into and enforce agreements with nations or groups of nations for the control of special nuclear materials and atomic weapons..." (Section 3(c)).

**Atomic Energy Commission:** A five-member commission, established by the Atomic Energy Act of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration. The Energy Research and Development Administration was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

**Attainment area:** An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the Clean Air Act. An area may be an attainment area for one pollutant and a non-attainment area for others.

**Background radiation:** Ionizing radiation present in the environment from cosmic rays and natural sources in the Earth; background radiation varies considerably with location. Also, see "natural radiation".

**Badged worker:** A worker equipped with an individual dosimeter who has the potential to be exposed to radiation.

**Basalt:** The most common volcanic rock. Basalt is dark-gray to black in color, high in iron and magnesium, and low in silica. It is typically found in lava flows.

**Base requirement:** The nuclear material quantity needed to support the nuclear weapons stockpile (new weapons builds, research and development, and tests) and other needs (nonweapons research and

development, isotopic power devices, and commercial sales).

**Baseline:** A quantitative expression of conditions, costs, schedule, or technical progress to serve as a base or standard for measurement during the performance of an effort; the established plan against which the status of resources and the progress of a project can be measured. For this Programmatic Environmental Impact Statement, the environmental baseline is the site environmental conditions as they are projected to occur in 2010.

**BEIR V:** Biological Effects of Ionizing Radiation; referring to the fifth in a series of committee reports from the National Research Council.

**Beryllium:** An extremely lightweight, strong metal used in weapons systems.

**Benthic:** Plants and animals dwelling at the bottom of oceans, lakes, rivers, and other surface waters.

**Beta activity:** The emission of beta particles by radioisotopes.

**Beta particle:** An elementary particle emitted from a nucleus during radioactive decay; it is negatively or positively charged, identical in mass to an electron, and in most cases easily stopped, as by a thin sheet of metal.

**Biofouling:** Aquatic organisms such as bacteria, fungi, algae, and mollusks, that colonize in waterflow structures (e.g., cooling water systems of power plants/reactors), often causing restricted water flow.

**Biological dose:** The radiation dose absorbed in biological material measured in rem or millirem (one-thousandth of a rem).

**Biota (biotic):** The plant and animal life of a region (pertaining to biota).

**Blanket assemblies:** In a heavy water reactor, lithium-aluminum alloy clad tubes positioned in a ring surrounding the radial reflector zone. They prevent neutron damage to the reactor vessel's metal wall by absorbing neutrons from the reflector zone, and they produce tritium.

**Boiling water reactor:** A type of nuclear reactor that uses fission heat to generate steam in the reactor to drive turbines and generate electricity.

**British thermal unit:** A unit of heat; the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit. One British thermal unit equals 1055 joules (or 252 calories).

**Burial ground:** A place for burying unwanted (i.e., radioactive) materials in which the earth acts as a receptacle to prevent the dispersion of wastes in the environment and the escape of radiation.

**Burnable poison rod:** A nuclear reactor rod used to moderate (reduce the energy of) neutrons created in the core by the fission reactions during the early core life.

**Calcareous:** Containing calcium carbonate (e.g., calcite or limestone).

**Calcination:** The process of converting high-level waste to unconsolidated granules or powder. Calcined solid wastes are primarily salts and oxides of metals (heavy metals) and components of high level waste (also called calcining).

**Caldera:** A large crater formed by the collapse of the central part of a volcano.

**Cancer:** The name given to a group of diseases characterized by uncontrolled cellular growth with cells having invasive characteristics such that the disease can transfer from one organ to another.

**Capable fault:** A fault that has exhibited one or more of the following characteristics (10 CFR 100, Appendix A):

1. Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.

2. Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.

3. A structural relationship to a capable fault according to characteristics (1) or (2) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.

**Capacity factor:** The ratio of the annual average power load of a power plant to its rated capacity.

**Carbon adsorption:** A unit physiochemical process in which organic and certain inorganic compounds in a liquid stream are absorbed on a bed of activated carbon; used in water or waste purification and chemical processing.

**Carbon dioxide:** A colorless, odorless, nonpoisonous gas that is a normal component of the ambient air; it is an expiration product of normal plant and animal life.

**Carbon monoxide:** A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

**Carolina bay:** Ovate, intermittently flooded depression of a type occurring on the Coastal Plain from New Jersey to Florida.

**Cask (radioactive materials):** A container that meets all applicable regulatory requirements for shipping spent nuclear fuel or high-level waste.

**Cenozoic Era:** A geologic era characterized by the dominance of advanced mollusks and mammals. The Cenozoic Era dates from 65 million years ago to the present.

**Cermet:** An alloy of a heat-resistant ceramic compound and a metal.

**Cermet fuel:** A ceramic-metal (or cermet) composite (uranium particles dispersed in an aluminum matrix) developed as an alternative to the current uranium-aluminum alloy fuel clad in aluminum.

**Cesium:** A silver-white alkali metal. A radioactive isotope of cesium, cesium-137, is a common fission product.

**Chemical oxygen demand:** A measure of the quantity of chemically oxidizable components present in water.

**Chronic exposure:** Low-level radiation exposure incurred over a long time period due to residual contamination.

**Chronic standard:** A numerical limit on the amount of a particular chemical contaminant that an organism may be exposed to over an extended period of time. The allowable exposure concentration for the chronic standard is less than that of the acute standard.

**Cladding:** The outer jacket of fuel elements and targets, usually made of aluminum, stainless steel, or zirconium-aluminum alloy, used to prevent fuel corrosion and retain fusion products during reactor operations, or to prevent releases into the environment during storage.

**Class 1E:** The safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling and containment, and reactor heat removal or that are otherwise essential in preventing a significant release of radioactive material to the environment.

**Class A facility:** A facility engaged in administrative activities considered essential to the overall direction and continuity of the protection program; engaged in research and development, manufacture, production, assembly, or storage of nuclear weapons, weapon assemblies, or military reactors; engaged in major research and development in uranium enrichment or operation of major uranium enrichment facilities; involved in research and development, manufacture, production, or assembly of nonnuclear weapon components, assemblies, and parts essential to the weapons or military reactor programs; or receiving, handling, or storing Top Secret documents (exclusive of keying material for secure communications) over an extended period. Or, a facility that possesses specified quantities of special nuclear material.

**Claystone:** A massive sedimentary rock made up largely of clay minerals having the composition of shale, but lacking its fine lamination.

**Clean Air Act:** This Act mandates and enforces air pollutant emissions standards for stationary sources and motor vehicles.

**Clean Air Act Amendments of 1990:** Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxics, ozone depleting chemicals, stationary and mobile emissions sources, and emissions implicated in rain and global warming.

**Clean Water Act of 1972, 1987:** This Act regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulates discharges to or dredging of wetlands.

**Climatology:** The science that deals with climates and investigates their phenomena and causes.

**Code of Federal Regulations:** All Federal regulations in force are published in codified form in the Code of Federal Regulations.

**Cold standby:** Maintenance of a protected reactor condition in which the fuel is removed, the moderator is stored in tanks, and equipment and system layup is performed to prevent deterioration, such that future refueling and restart are possible.

**Collapse depression:** A depression formed when underground lava or gases move or escape (e.g., in an eruption) and the ground above collapses.

**Collective committed effective dose equivalent:** The committed effective dose equivalent of radiation for a population.

**Committed dose equivalent:** The predicted total dose equivalent to a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does not include external dose contributions. Committed dose equivalent is expressed in units of rem or Sievert. The committed effective dose equivalent is the sum of the committed dose equivalents to various tissues of the body, each multiplied by the appropriate weighting factor.

**Community (biotic):** All plants and animals occupying a specific area under relatively similar conditions.

**Complex:** The Nuclear Weapons Complex, which is a set of Federal sites and government-owned/contractor-operated facilities administered by the Department of Energy.

**Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (or Superfund):** This Act provides regulatory framework for remediation of past contamination from hazardous waste. If a site meets the Act's requirements for designation, it is ranked along with other "Superfund" sites and is listed on the National Priorities List. This ranking is the Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

**Conceptual design:** Efforts to develop a project scope that will satisfy program needs; ensure project feasibility and attainable performance levels of the project for congressional consideration; develop project criteria and design parameters for all engineering disciplines; and identify applicable codes and standards, quality assurance requirements, environmental studies, construction materials, space allowances, energy conservation features, health, safety, safeguards, and security requirements and any other features or requirements necessary to describe the project.

**Confined aquifer:** A permeable geological unit with an upper boundary that is at a pressure higher than atmospheric pressure.

**Conglomerate:** A rock that contains rounded rock fragments or pebbles, cemented together by another mineral substance.

**Consumptive water use:** The difference in the volume of water withdrawn from a body of water and the amount released back into the body of water.

**Container:** The metal envelope in the waste package that provides the primary containment function of the waste package and is designed to meet the containment requirements of 10 CFR 60.

**Containment design basis:** For a nuclear reactor, those bounding conditions for the design of the containment, including temperature, pressure, and leakage rate. Because the containment is provided as an additional barrier to mitigate the consequences of accidents involving the release of radioactive materials, the containment design basis may include an additional specified margin above those conditions expected to result from the plant design-basis accidents to ensure that the containment design can mitigate unlikely or unforeseen events.

**Control rods:** The elements of a nuclear reactor that absorb slow neutrons and are used to increase, decrease, or maintain the neutron density in the reactor.

**Coolant:** A substance, either gas or liquid, circulated through a nuclear reactor or processing plant to remove heat.

**Credible accident:** An accident that has a probability of occurrence greater than or equal to one in a million years.

**Cretaceous:** The geologic period making up the end of the Mesozoic Era, dating from approximately 144 million to 66 million years ago.

**Criteria pollutants:** Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency: sulfur dioxide, nitric oxides, carbon monoxide, ozone, particulate matter (smaller than 10 microns in diameter), and lead.

**Critical habitat:** Defined in the Endangered Species Act of 1973 as "specific areas within the geographical area occupied by [an endangered or threatened] species..., essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species... that are essential for the conservation of the species."

**Critical mass:** The smallest mass of fissionable material that will support a self-sustaining nuclear chain reaction under specified conditions.

**Criticality:** A reactor state in which a self-sustaining nuclear chain reaction is achieved.

**Crystalline rock:** Rock consisting of minerals in a crystalline state.

**Cultural resources:** Archaeological sites, architectural features, traditional use areas, and Native American sacred sites.

**Curie:** A unit of radioactivity equal to 37 billion disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 curie of radioactivity.

**Decay heat (radioactivity):** The heat produced by the decay of certain radionuclides.

**Decay (radioactive):** The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous transformation of an unstable nuclide into a different nuclide or into a different energy state of the same nuclide; the emission of nuclear radiation (alpha, beta, or gamma radiation) is part of the process.

**Decibel:** A unit of sound measurement. In general, a sound doubles in loudness for every increase of 10 decibels.

**Decibel, A-weighted:** A unit of weighted sound pressure level, measured by the use of a metering characteristic and the "A" weighting specified by the American National Standard Institute S1.4-1971(R176).

**Decontamination:** The removal of radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

**Demilitarization:** An irreversible modification or destruction of a weapons component or part of a component to the extent required to prevent use in its original weapon purpose.

**Demography:** The statistical study of human populations, including size, density, distribution, and such vital statistics as age, sex, and ethnicity.

**Depleted uranium:** Uranium whose content of the isotope uranium-235 is less than 0.7 percent, which is

the uranium-235 content of naturally occurring uranium.

**Deposition:** In geology, the laying down of potential rock-forming materials; sedimentation. In atmospheric transport, the settling out on ground and building surfaces of atmospheric aerosols and particles ("dry deposition") or their removal from the air to the ground by precipitation ("wet deposition" or "rainout").

**Derived concentration guide:** The concentration of a radionuclide in air or water which, under conditions of continuous exposure by one exposure mode (i.e., ingestion of water or submersion or inhalation of air) for one year, a "reference man" would receive the most restrictive of: (1) an effective dose equivalent or 100 mrem, or (2) a dose equivalent of 5 rem to any tissues, including skin and lens of the eye.

**Design basis:** For nuclear facilities, information that identifies the specific functions to be performed by a structure, system, or component and the specific values (or ranges of values) chosen for controlling parameters for reference bounds for design. These values may be: (1) restraints derived from generally accepted state-of-the-art practices for achieving functional goals; (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals; or (3) requirements derived from Federal safety objectives, principles, goals, or requirements.

**Design-basis accident:** For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to (1) maintain them in a safe shutdown condition indefinitely or (2) prevent or mitigate the consequences of the design-basis accident so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

**Design-basis events:** Postulated disturbances in process variables that can potentially lead to design-basis accidents.

**Design laboratory:** Department of Energy facilities involved in the design of nuclear weapons.

**Design power:** The thermal power rating of a tritium-production reactor that, when combined with the anticipated capacity factor, will produce the goal tritium requirement.

**Detritus:** Dead organic material and organisms.

**Deuterium:** A nonradioactive isotope of the element hydrogen with one neutron and one proton in the atomic nucleus.

**Deuterium oxide:** See "heavy water."

**Dewatering:** Pumping water from the soil to ensure proper soil characteristics for construction of facilities. May be required during operation if the water table impinges on foundations.

**Dip:** The acute angle that a structural surface (e.g., a bedding or fault plane) in a geologic material makes with the horizontal, measured perpendicular to the strike of the surface. Updip is at a higher elevation on the surface.

**Direct economic effects:** The initial increases in output from different sectors of the economy resulting from some new activity within a predefined geographic region.

**Disposition:** The ultimate "fate" or end use of a surplus Department of Energy facility following the transfer of the facility to the Office of the Assistant Secretary for Environmental Waste Management.

**Dolomite:** Calcium magnesium carbonate, a limestone-like mineral.

**Dose:** The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad.

**Dose commitment:** The dose an organ or tissue would receive during a specified period of time (e.g., 50 to 100 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a defined release, frequently over a year's time.

**Dose equivalent:** The product of absorbed dose in rad (or gray) and the effect of this type of radiation in tissue and a quality factor. Dose equivalent is expressed in units of rem or Sievert, where 1 rem equals 0.01 Sievert. The dose equivalent to an organ,

tissue, or the whole body will be that received from the direct exposure plus the 50-year committed dose equivalent received from the radionuclides taken into the body during the year.

**Dosimeter:** A small device (instrument) carried by a radiation worker that measures cumulative radiation dose (e.g., film badge or ionization chamber).

**Downthrow:** The rocks on the side of a fault that have moved downward relative to the rocks on the other side of the fault.

**Drainage basin:** An aboveground area that supplies the water to a particular stream.

**Drawdown:** The height difference between the natural water level in a formation and the reduced water level in the formation caused by the withdrawal of groundwater.

**Drift:** Effluent mist or spray carried into the atmosphere from cooling towers.

**Drinking-water standards:** The prescribed level of constituents or characteristics in a drinking water supply that cannot be exceeded legally.

**Dry site:** For the purpose of this Programmatic Environmental Impact Statement any site where adequate water is not abundantly available for cooling of the tritium supply technologies.

**Effective dose equivalent:** The summation of the products of the dose equivalent received by specified tissues of the body and a tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the health effects risk of the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides, and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem (or Sievert).

**Effective porosity:** A measure of the interconnected pore space in a rock or soil material that permits the flow of water.

**Effluent:** A gas or fluid discharged into the environment.

**Emergency condition:** For a nuclear facility, occurrences or accidents that might occur infrequently during start-up testing or operation of the facility. Equipment, components, and structures might be deformed by these conditions to the extent that repair is required prior to reuse.

**Emission standards:** Legally enforceable limits on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

**Endangered species:** Animals, birds, fish, plants, or other living organisms threatened with extinction by man-made or natural changes in their environment. Requirements for declaring species endangered are contained in the Endangered Species Act of 1973.

**Endangered Species Act of 1973:** This Act requires Federal agencies, with the consultation and assistance of the Secretaries of the Interior and Commerce, to ensure that their actions will not likely jeopardize the continued existence of any endangered or threatened species or adversely affect the habitat of such species.

**Energy conversion area:** A facility that produces electricity from steam generated by reactor heat.

**Engineered safety features:** For a nuclear facility, features that prevent, limit, or mitigate the release of radioactive material from its primary containment.

**Entrainment:** The involuntary capture and inclusion of organisms in streams of flowing water, a term often applied to the cooling water systems of power plants/reactors. The organisms involved may include phyto- and zooplankton, fish eggs and larvae (ichthyoplankton), shellfish larvae, and other forms of aquatic life.

**Environment, safety, and health program:** In the context of the Department of Energy, encompasses those Department of Energy requirements, activities, and functions in the conduct of all Department of

Energy and Department of Energy-controlled operations that are concerned with: impacts to the biosphere; compliance with environmental laws, regulations, and standards controlling air, water, and soil pollution; limiting the risks to the well-being of both operating personnel and the general public to acceptably low levels; and protecting property adequately against accidental loss and damage. Typical activities and functions related to this program include, but are not limited to, environmental protection, occupational safety, fire protection, industrial hygiene, health physics, occupational medicine, and process and facilities safety, nuclear safety, emergency preparedness, quality assurance, and radioactive and hazardous waste management.

**Environmental assessment:** A written environmental analysis that is prepared pursuant to the National Environmental Policy Act to determine whether a Federal action would significantly affect the environment and thus require preparation of a more detailed environmental impact statement. If the action does not significantly affect the environment, then a finding of no significant impact is prepared.

**Environmental audit:** A documented assessment of a facility to monitor the progress of necessary corrective actions, to ensure compliance with environmental laws and regulations, and to evaluate field organization practices and procedures.

**Environmental documentation:** Documents describing information and results from studies and evaluations required by National Environmental Policy Act. This documentation includes both an environmental assessment and an environmental impact statement.

**Environmental impact statement:** A document required of Federal agencies by National Environmental Policy Act for major proposals or legislation significantly affecting the environment. A tool for decision-making, it describes the positive and negative effects of the undertaking and alternative actions.

**Environmental survey:** A documented, multidisciplined assessment (with sampling and analysis) of a facility to determine environmental conditions and to identify environmental problems requiring corrective action.

**Eocene:** A geologic epoch early in the Cenozoic Era, dating from approximately 54 to 38 million years ago.

**Ephemeral stream:** A stream that flows only after a period of heavy precipitation.

**Epicenter:** The point on the Earth's surface directly above the focus of an earthquake.

**Epidemiology:** The science concerned with the study of events that determine and influence the frequency and distribution of disease, injury, and other health-related events and their causes in a defined human population.

**Equivalent sound (pressure) level ($L_{eq}$):** The equivalent steady sound level that, if continuous during a specified time period, would contain the same total energy as the actual time-varying sound. For example, $L_{eq}$ (1-h) and $L_{eq}$ (24-h) are the 1-hour and 24-hour equivalent sound level, respectively.

**Exposure limit:** The level of exposure to a hazardous chemical (set by law or a standard) at which or below which adverse human health effects are not expected to occur:

- Reference dose is the chronic exposure dose (mg/kg/day) for a given hazardous chemical at which or below which adverse human non-cancer health effects are not expected to occur.

- Reference concentration is the chronic exposure concentration ($mg/m^3$) for a given hazardous chemical at which or below which adverse human non-cancer health effects are not expected to occur.

**Fault:** A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred. A normal fault occurs when the hanging wall has been depressed in relation to the footwall. A reverse fault occurs when the hanging wall has been raised in relation to the footwall.

**Fault-plane:** A fault surface that is more or less flat or level.

**Finding of No Significant Impact:** A document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant effect on the human environment and will not require an environmental impact statement.

**Fissile material:** Plutonium-239, uranium-233, uranium-235, or any material containing any of the foregoing.

**Fission:** The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

**Fission products:** Nuclei formed by the fission of heavy elements (primary fission products); also, the nuclei formed by the decay of the primary fission products, many of which are radioactive.

**Fissure:** A long and narrow crack in the earth.

**Floodplain:** The lowlands adjoining inland and coastal waters and relatively flat areas including at a minimum that area inundated by a 1-percent or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0 percent) floodplain. The critical action floodplain is defined as the 500-year (0.2 percent) floodplain.

**Flux:** Rate of flow through a unit area; in reactor operation, the apparent flow of neutrons in a defined energy range (see neutron flux).

**Footwall:** The mass of rock beneath a fault plane.

**Formation:** In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

**Fossil:** Impression or trace of an animal or plant of past geological ages that has been preserved in the earth's crust.

**Fossiliferous:** Containing a relatively large number of fossils.

**Fugitive emissions:** Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

**Gamma rays:** High-energy, short-wavelength, electromagnetic radiation accompanying fission and emitted from the nucleus of an atom. Gamma rays are very penetrating and can be stopped only by dense materials (such as lead) or a thick layer of shielding materials.

**Gaussian plume:** The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline (Gaussian distribution), depends on the mean wind speed and atmospheric stability.

**Genetic effects:** The outcome resulting from exposure to mutagenic chemicals or radiation which results in genetic changes in germ line or somatic cells.

- Effects on genetic material in germ line (sex cells) cause trait modifications that can be passed from parents to offspring.

- Effects on genetic material in somatic cells result in tissue or organ modifications (e.g. liver tumors) that do not pass from parents to offspring.

**Geologic repository (mined geologic repository):** A facility for the disposal of nuclear waste; the waste is isolated by placement in a continuous, stable geologic formation at depths greater than 300 meters.

**Geology:** The science that deals with the Earth: the materials, processes, environments, and history of the planet, including the rocks and their formation and structure.

**Getter:** A material capable of capturing gases. In a tritium supply reactor, a material incorporated into the tritium target to prevent buildup of pressure in the target and prevent loss of tritium.

**Glove box:** An airtight box used to work with hazardous material, vented to a closed filtering

system, having gloves attached inside of the box to protect the worker.

**Gneiss:** A metamorphic rock comprised of bands of granular minerals alternating with bands of minerals that are flaky or have elongate prismatic habits.

**Ground shine:** An area on the ground where radioactivity has been deposited by a radioactive plume or cloud.

**Groundwater:** The supply of water found beneath the Earth's surface, usually in aquifers, which may supply wells and springs.

**Guideline level:** A suggested, desired level of concentration. It is not a regulatory value, but is a value offered as desirable by an agency to protect human health or the environment.

**Half-life (radiological):** The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies for specific radioisotopes from millionths of a second to billions of years.

**Hazard Index:** A summation of the Hazard Quotients for all chemicals now being used at a site and those proposed to be added to yield cumulative levels for a site. A Hazard Index value of 1.0 or less means that no adverse human health effects (non-cancer) are expected to occur.

**Hazard Quotient:** The value used as an assessment of non-cancer associated toxic effects of chemicals, e.g., kidney or liver dysfunction. It is independent of a cancer risk, which is calculated only for those chemicals identified as carcinogens.

**Hazardous material:** A material, including a hazardous substance, as defined by 49 CFR 171.8 which poses a risk to health, safety, and property when transported or handled.

**Hazardous/toxic waste:** Any solid waste (can also be semisolid or liquid, or contain gaseous material) having the characteristics of ignitability, corrosivity, toxicity, or reactivity, defined by the Resource Conservation and Recovery Act and identified or listed in 40 CFR 261 or by the Toxic Substances Control Act.

**Heat exchanger:** A device that transfers heat from one fluid (liquid or gas) to another.

**Heavy metals:** Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

**Heavy water:** A form of water (a molecule with two hydrogen atoms and one oxygen atom) in which the hydrogen atoms consist largely or completely of the deuterium isotope. Heavy water has almost identical chemical properties, but quite different nuclear properties, as light water (common water).

**Heavy Water Reactor:** A nuclear reactor in which circulating heavy water is used to cool the reactor core and to moderate (reduce the energy of) the neutrons created in the core by the fission reactions.

**High efficiency particulate air filter:** A filter used to remove particulates from dry gaseous effluent streams.

**High-level waste:** The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid. High-level waste contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

**Highly enriched uranium:** Uranium in which the abundance of the isotope uranium-235 is increased well above normal (naturally occurring) levels.

**Historic resources:** Archaeological sites, architectural structures, and objects produced after the advent of written history dating to the time of the first Euro-American contact in an area.

**Holocene:** The current epoch of geologic time, which began approximately 10,000 years ago.

**Hydraulic conductivity:** The constant of proportionality in Darcy's Law of fluid flow that describes the ease with which a porous medium permits fluids to flow and the ease with which the fluid flows given its physical properties.

**Hydraulic gradient:** The difference in hydraulic head at two points divided by the distance between two points.

**Hydrology:** The science dealing with the properties, distribution, and circulation of natural water systems.

**Hydrostratigraphic unit:** Rock or soil body extending laterally for a considerable distance that is a recognized water bearing unit.

**Immersion dose:** Dose resulting from being surrounded by a medium (air or water) that contains radionuclides.

**Impingement:** The process by which aquatic organisms too large to pass through the screens of a water intake structure become caught on the screens and are unable to escape.

**Incident-free risk:** The radiological or chemical impacts resulting from packages aboard vehicles in normal transport. This includes the radiation or hazardous chemical exposure of specific population groups such as crew, passengers, and bystanders.

**Indirect economic effects:** Indirect effects result from the need to supply industries experiencing direct economic effects with additional outputs to allow them to increase their production. The additional output from each directly affected industry requires inputs from other industries within a region (i.e., purchases of goods and services). This results in a multiplier effect to show the change in total economic activity resulting from a new activity in a region.

**Induced economic effects:** The spending of households resulting from direct and indirect economic effects. Increases in output from a new economic activity lead to an increase in household spending throughout the economy as firms increase their labor inputs.

**Inertial confinement fusion:** A laser initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.

**Injection wells:** A well that takes water from the surface into the ground, either through gravity or by mechanical means.

**Interbedded:** Occurring between beds or lying in a bed parallel to other beds of a different material.

**Interfluvial:** Falling in the area between two streams.

**Interim (permit) status:** Period during which treatment, storage, and disposal facilities coming under the Resource Conservation and Recovery Act of 1980 are temporarily permitted to operate while awaiting denial or issuance of a permanent permit.

**Ion exchange:** A unit physiochemical process that removes anions and cations, including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

**Ionizing radiation:** Radiation that can displace electrons from atoms or molecules, thereby producing ions.

**Isotope:** An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses.

**Joule:** A metric unit of energy, work, or heat, equivalent to 1 watt-second, 0.737 foot-pound, or 0.239 calories.

**Jurassic:** The middle period of the Mesozoic Era, dating from 208 million to 144 million years ago.

**Klystron:** An electron tube used for the generation of ultrahigh-frequency current.

**Lacustrine:** Found or formed in lakes; also, a type of wetland situated on or near a lake.

**Landscape character:** The arrangement of a particular landscape as formed by the variety and intensity of the landscape features (land, water, vegetation, and structures) and the four basic elements (form, line, color, and texture). These factors give an area a distinctive quality that distinguishes it from its immediate surroundings.

**Large release:** A release of radioactive material that would result in doses greater than 25 rem to the whole body or 300 rem to the thyroid at 1.6 kilometer

from the control perimeter (security fence) of a reactor facility.

**Latent fatalities:** Fatalities associated with acute and chronic environmental exposures to chemical or radiation that occur within 30 years of exposure.

**Lava tube:** A hollow, cylindrical rock formation created by a stream of flowing lava when the outside of the stream cools and hardens while the inside remains hot and fluid.

**Level-1 probabilistic risk assessment:** The portion of a nuclear reactor probabilistic risk assessment that involves the analysis of core damage potential.

**Level-2 probabilistic risk assessment:** The portion of a nuclear reactor probabilistic risk assessment that models core damage progression, confinement systems response, and radionuclide release and behavior.

**Level-3 probabilistic risk assessment:** The portion of a nuclear reactor probabilistic risk assessment that evaluates the consequences of a radionuclide release.

**Light water:** The common form of water (a molecule with two hydrogen atoms and one oxygen atom) in which the hydrogen atom consists largely or completely of the normal hydrogen isotope (one proton).

**Light Water Reactor:** A nuclear reactor in which circulating light water is used to cool the reactor core and to moderate (reduce the energy of) the neutrons created in the core by the fission reactions.

**Lithic:** Pertaining to stone or a stone tool.

**Lithic scatter:** An archaeological site consisting of stone artifacts and by-products of their maintenance.

**Lithologic:** Pertaining to the structure and composition of a rock.

**Loam:** A soil composed of a mixture of clay, silt, sand, and organic matter.

**Long-lived radionuclides:** Radioactive isotopes with half-lives greater than about 30 years.

**Loss-of-coolant accidents:** A postulated accident that results from the loss of reactor coolant (at a rate that exceeds the capability of the reactor coolant makeup system) from breaks in the reactor coolant pressure boundary, up to and including a break equivalent in size to the double-ended rupture of the largest pipe of the reactor coolant system.

**Loss-of-pumping accidents:** An event that involves a pipe break through which coolant (either primary or secondary) is released.

**Low-level waste:** Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material" as defined by DOE Order 5820.2A, *Radioactive Waste Management.* Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram. Some low-level waste is considered classified because of the nature of the generating process and/or constituents, because the waste would tell too much about the process.

**Mandatory standards:** Standards adopted by the Department of Energy that define the minimum requirements that the Department of Energy and its contractors must comply with. Standards may be classified as mandatory because of applicable Federal or state statutes or implementing requirements, or as a matter of Department of Energy policy.

**Marsh:** An area of low-lying wetland, dominated by grasslike plants.

**Mastodon:** Any of numerous extinct mammals that differ from the related mammoths and existing elephants chiefly in the form of molar teeth.

**Maximum contaminant level:** The maximum permissible level of a contaminant in water delivered to any user of a public water system. Maximum contaminant levels are enforceable standards.

**Maximally exposed individual:** A hypothetical person who could potentially receive the maximum dose of radiation or hazardous chemicals.

**Megawatt:** A unit of power equal to 1 million watts. Megawatt thermal is commonly used to define heat produced, while megawatt electric defines electricity produced.

**Mesozoic:** The geologic era dating from 245 million to 66 million years ago. The Mesozoic Era is the era of the dinosaurs.

**Meteorology:** The science dealing with the atmosphere and its phenomena, especially as relating to weather.

**Migration:** The natural movement of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.

**Miocene:** A geologic epoch in the Cenozoic Era dating from 26 to 7 million years ago.

**Mississippian Period (geologic):** A portion of the Paleozoic Era in North America dating from 360 to 330 million years ago (following the Devonian Period and preceding the Pennsylvanian Period).

**Mixed waste:** Waste that contains both "hazardous waste" and "radioactive waste" as defined in this glossary.

**Moderator:** A material used to decelerate neutrons in a reactor from high energies to low energies.

**Modified Mercalli intensity:** A level on the modified Mercalli scale. A measure of the perceived intensity of earthquake ground shaking with 12 divisions, from I (not felt by people) to XII (damage nearly total).

**Modular High Temperature Gas-Cooled Reactor:** A relatively small nuclear reactor of standardized design in which graphite (a compound of electrical carbon) is used to moderate (reduce the energy of) the neutrons created in the core by fission reactions, and a gas (helium) is used to cool the reactor core

**Mollusks:** Unsegmented, invertebrate animals including gastropods, pelecypods, and cephalopods.

**National Ambient Air Quality Standards:** Air quality standards established by the Clean Air Act, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

**National Emission Standards for Hazardous Air Pollutants:** A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.

**National Environmental Policy Act of 1969:** This Act is the basic national charter for the protection of the environment. It requires the preparation of an environmental impact statement for every major Federal action that may significantly affect the quality of the human or natural environment. Its main purpose is to provide environmental information to decision makers so that their actions are based on an understanding of the potential environmental consequences of a proposed action and its reasonable alternatives.

**National Environmental Research Park:** An outdoor laboratory set aside for ecological research to study the environmental impacts of energy developments. National environmental research parks were established by the Department of Energy to provide protected land areas for research and education in the environmental sciences and to demonstrate the environmental compatibility of energy technology development and use.

**National Historic Preservation Act of 1966, as amended:** This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.

**National Pollutant Discharge Elimination System:** Federal permitting system required for hazardous effluents regulated through the Clean Water Act, as amended.

**National Register of Historic Places:** A list maintained by the Secretary of the Interior of districts,

sites, buildings, structures, and objects of prehistoric or historic local, state, or national significance. The list is expanded as authorized by Section 2(b) of the Historic Sites Act of 1935 (16 U.S.C. 462) and Section 101(a)(1)(A) of the National Historic Preservation Act of 1966, as amended.

**Neutron:** An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

**Neutron flux:** The product of neutron number density and velocity (energy) giving an apparent number of neutrons flowing through a unit area per unit time.

**Neutron poison:** A chemical solution (e.g., boron or rare earth solution) injected into a nuclear reactor to absorb neutrons and end criticality.

**Noise Control Act of 1972:** This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

**Nonattainment area:** An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.

**Notification level:** A term used only in National Pollutant Discharge Elimination System permitting. Discharges are permitted under National Pollutant Discharge Elimination System for particular parameters; however, when parameters that have not been permitted appear in excess of a predetermined concentration (i.e., 100 milligrams per liter), the discharger is required by the National Pollutant Discharge Elimination System permit to notify the permitter (the Environmental Protection Agency) that a new parameter has appeared. Violations of National Pollutant Discharge Elimination System concentration limits are usually called "noncompliances."

**Nitrogen oxides:** Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and $NO_2$ (nitrogen dioxide). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, such as ammonia or carbon monoxide, ozone is produced.

**Nuclear criticality:** (See "criticality.)

**Nuclear facility:** A facility whose operations involve radioactive materials in such form and quantity that a nuclear hazard potentially exists to the employees or the general public. Included are facilities that: produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium; conduct separations operations; conduct irradiated materials inspection, fuel fabrication, decontamination, or recovery operations; or conduct fuel enrichment operations. Incidental use of radioactive materials in a facility operation (e.g., check sources, radioactive sources, and X-ray machines) does not necessarily require a facility to be included in this definition.

**Nuclear grade:** Material of a quality adequate for use in a nuclear application.

**Nuclear material:** Composite term applied to: (1) special nuclear material; (2) source material such as uranium or thorium or ores containing uranium or thorium; and (3) by-product material, which is any radioactive material that is made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material.

**Nuclear power plant:** A facility that converts nuclear energy into electrical power. Heat produced in a nuclear reactor is used to make steam which drives a turbine connected to an electric generator.

**Nuclear production:** Production operations for components of nuclear weapons that are fabricated from nuclear materials, including plutonium and uranium.

**Nuclear reaction:** A reaction in which an atomic nucleus is transformed into another isotope of that respective nuclide, or into another element altogether; it is always accompanied by the liberation of either particles or energy.

**Nuclear reactor:** A device in which a fission chain reaction is maintained, and which is used for irradiation of materials or to produce heat for the generation of electricity.

**Nuclide:** A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

**Obsidian:** A black volcanic glass.

**Occupational Safety and Health Administration:** Oversees and regulates workplace health and safety, created by the Occupational Safety and Health Act of 1970.

**Onsite population:** Department of Energy and contractor employees who are on duty, and badged onsite visitors.

**Operable:** For a nuclear facility, a situation wherein a reactor and fuel/target cycle facilities are being operated or have the potential for being operated. A reactor and fuel/target cycle facility that cannot be operated on a day-to-day basis because of refueling, extensive modifications, or technical problems is still considered operable.

**Operable unit:** A discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration or eliminates or mitigates a release, threat of release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units.

**Outfall:** The discharge point of a drain, sewer, or pipe as it empties into a body of water.

**Ozonation process:** A water treatment process in which ozone is employed as a disinfectant.

**Ozone:** The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere ozone is considered an air pollutant.

**Packaging:** The assembly of components necessary to ensure compliance with Federal regulations. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.

**Paleoindian:** Term applied to both: (1) the period to which the earliest presence of humans can be traced, dating in North America to the late Pleistocene (ca. 10-12,000 B.P.), and (2) the earliest human groups identified in North America (e.g., Clovis and Folsom points are considered to have been manufactured by Paleoindian peoples).

**Paleontology:** The study of fossils.

**Paleozoic:** The longest era of geologic time, dating from 570 million to 245 million years ago. Seed-bearing plants, amphibians, and reptiles first appeared in the Paleozoic Era.

**Palustrine:** Found or formed in marshes; also, a type of wetland situated in or near a marsh.

**Pascal:** A metric unit of pressure equal to one neutron per square meter; 101,000 pascals is equal to 14.7 pounds per square inch.

**Perched groundwater:** A body of groundwater of small lateral dimensions lying above a more extensive aquifer.

**Perennial creek:** A stream or reach of a stream that flows continuously throughout the year and whose upper surface generally stands lower than the water table in the region adjoining the stream.

**Permeability:** geology, the ability of rock or soil to transmit a fluid.

**Person-rem:** The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population segment.

**Petroglyph:** Art carved or inscribed on a rock by a historic or prehistoric people.

**Physical setting:** The land and water form, vegetation, and structures that compose the landscape.

**Physiography:** Description of Earth surface features.

**Piedmont province:** Area of rolling topography between the Appalachian mountain range and the coastal plain, extending from New Jersey to Alabama.

**Pit:** An assembly at the center of a nuclear device containing a sub-critical mass of fissionable material.

**Playa:** A dry lake bed in a desert basin or a closed depression that contains water on a seasonal basis.

**Pleistocene:** The geologic epoch that began approximately 3 to 5 million years ago.

**Pliocene:** Geologic epoch between the Miocene and the Pleistocene epochs approximately 2 to 13 million years ago.

**Plume:** The elongated pattern of contaminated air or water originating at a point source, such as a smokestack or a hazardous waste disposal site.

**Plume immersion:** Occurs when an individual is enveloped by a cloud of radioactive gaseous effluent and receives an external radiation dose.

**Plutonium:** A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

**Potential of hydrogen:** A measure of the hydrogen ion concentration in aqueous solution (symbol pH). Pure water has a pH of 7, acidic solutions have a pH less than 7, and basic solutions have a pH greater than 7.

**Potentiometric surface:** An imaginary surface defined by the level that water will rise to in a tightly-cased well.

**Pounds per square inch:** A measure of pressure; atmospheric pressure is about 14.7 pounds per square inch.

**Pre-Cambrian:** Dating from before the Cambrian geologic period more than 570 million years ago.

**Prehistoric:** Predating written history. In North America, also predating contact with Europeans.

**Pressurized water reactor:** A nuclear power reactor that uses water under pressure as a coolant. The water boiled to generate steam is in a separate system.

**Prevention of Significant Deterioration:** Regulations established by the 1977 Clean Air Act Amendments to limit increases in criteria air pollutant concentrations above baseline.

**Primary system:** The system that circulates a coolant (e.g., water) through the reactor core to remove the heat of reaction.

**Prime farmland:** Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oil-seed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor without intolerable soil erosion, as determined by the Secretary of Agriculture (Farmland Protection Policy Act of 1981, 7 CFR 7, paragraph 658).

**Probabilistic risk assessment:** A comprehensive, logical, and structured methodology to identify and quantitatively evaluate significant accident sequences and their consequences. (See "Level-1 probabilistic risk assessment, Level-2 probabilistic risk assessment, and Level-3 probabilistic risk assessment.")

**Probable maximum flood:** Flood levels predicted for a scenario having hydrological conditions that maximize the flow of surface waters.

**Protected area:** An area encompassed by physical barriers, subject to access controls, surrounding material access areas, and meeting the standards of DOE Order 5632.1C, *Protection and Control of Safeguards and Security Interests.*

**Quality factor:** The principal modifying factor that is employed to derive dose equivalent from absorbed dose.

**Quartzite:** A hard metamorphic rock composed predominantly of quartz and derived from sandstone.

**Rad:** See "radiation absorbed dose."

**Radiation:** The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

**Radiation absorbed dose:** The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.

**Radioactive accident risk:** As described in the *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes* (NUREG-0170), it is the probability of an accident in which the release of radioactive material is likely to occur, and its consequences. The consequences are expressed in terms of the potential effects of the release of a specified quantity of dispersible radioactive material to the environment or the exposure resulting from a damaged package shielding. The risk calculations incorporate accident rates and package release fraction estimates, both of which are functions of accident severity. Radiological accident risks are expressed in terms of annual expected latent cancer fatalities and early fatality probabilities.

**Radioactive vehicle accident:** A vehicle accident involving one or more packages of radioactive material that could result in a loss of shielding efficiency of the package, or a loss of containment and subsequent dispersal of the radioactive material, or an accidental assembly of a critical mass (in fissile material shipments).

**Radioactive waste:** Materials from nuclear operations that are radioactive or are contaminated with radioactive materials, and for which use, reuse, or recovery are impractical.

**Radioactivity:** The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

**Radioisotopes:** Radioactive nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons.

**Radionuclide:** A radioactive element characterized according to its atomic mass and atomic number which can be man-made or naturally occurring. Radionuclides can have a long life as soil or water pollutants, and are believed to have potentially mutagenic or carcinogenic effects on the human body.

**Radon:** Gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment, and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

**RADTRAN:** A computer code combining user-determined meteorological, demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.

**Reactor accident:** See "design-basis accident; severe accident."

**Reactor charge:** The fuel and target assemblies loaded into specific positions in the reactor to produce the desired product; the reactor positions occupied by the assemblies depend on the product and the types of assemblies used.

**Reactor core:** In a heavy water reactor: the fuel assemblies, including the fuel and target tubes, control assemblies, blanket assemblies, safety rods, and coolant/moderator. In a light-water reactor: the fuel assemblies, including the fuel and target rods, control rods, and coolant/ moderator. In a modular high-temperature gas-cooled reactor: the graphite elements, including the fuel and target elements, control rods, any other reactor shutdown mechanisms, and the graphite reflectors.

**Reactor facility:** Unless it is modified by words such as containment, vessel, or core, the term reactor facility includes the housing, equipment, and associated areas devoted to the operation and maintenance of one or more reactor cores. Any apparatus that is designed or used to sustain nuclear chain reactions in a controlled manner, including critical and pulsed assemblies and research, test, and power reactors, is defined as a reactor. All assemblies designed to

perform subcritical experiments that could potentially reach criticality are also to be considered reactors.

**Reactor year:** A unit of time by which accident frequency and core damage frequency are measured; it assumes that more than one reactor can operate during the year (a calendar year during which three reactors operated would be the experience equivalent of 3 reactor years) and it assumes that a reactor might not operate continuously for the entire year (a reactor operating only 60 percent of the calendar year would be the equivalent of 0.6 reactor year).

**Receiving waters:** Rivers, lakes, oceans, or other bodies of water into which wastewaters are discharged.

**Recharge:** Replenishment of water to an aquifer.

**Recycling:** The recovery, purification, and reuse of tritium contained in tritium reservoirs within the nuclear weapons stockpile.

**Reference standards:** Guides or standards that the Department of Energy and its contractors should consider for guidance, as applicable, in addition to mandatory standards.

**Rem:** See "roentgen equivalent man."

**Remediation:** The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.

**Resource Conservation and Recovery Act, as amended:** The Act that provides "cradle to grave" regulatory program for hazardous waste which established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

**Rhyolite:** A volcanic rock rich in silica; the volcanic equivalent of granite.

**Riparian wetlands:** Wetlands on or around rivers and streams.

**Riprap:** A loose assemblage of stones used in water or soft ground to prevent erosion.

**Risk:** A quantitative or qualitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event.

**Risk assessment (chemical or radiological):** The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological pollutants.

**Roentgen:** A unit of exposure to ionizing X- or gamma radiation equal to or producing 1 electrostatic unit of charge per cubic centimeter of air. It is approximately equal to 1 rad.

**Roentgen equivalent man:** The unit of radiation dose for biological absorption: equal to the product of the absorbed dose, in rads, a quality factor which accounts for the variation in biological effectiveness of different types of radiation. Also known as "rem".

**Runoff:** The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually enters streams.

**Ruthenium:** A brittle gray metal. A radioactive form of ruthenium is a common fission product.

**Safe Drinking Water Act, as amended:** This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

**Safe secure trailer:** A specially designed semi-trailer, pulled by an armored tractor, which is used for the safe, secure transportation of cargo containing nuclear weapons or special nuclear material.

**Safety Analysis Report:** A safety document providing a concise but complete description and safety evaluation of a site, design, normal and emergency operation, potential accidents, predicted consequences of such accidents, and the means proposed to prevent such accidents or mitigate their consequences. A safety analysis report is designated as final when it is based on final design information. Otherwise, it is designated as preliminary.

**Safety Class 1:** One of three levels assigned to components, systems, or structures that must be designed to provide certain functions to protect operators, the public, or the environment. This class is concerned with function and/or structural integrity for the mitigation of severe events, including design-basis accidents.

**Safety document:** A document prepared specifically to ensure that the safety aspects of part or all of the activities conducted at a reactor are formally and thoroughly analyzed, evaluated, and recorded (for example, technical specifications, safety analysis reports and addenda, and documented reports of special safety reviews and studies).

**Saltcrete:** A solidified mixture of salt residue from the evaporation process at a liquid waste treatment facility and Portland cement.

**Saltstone:** Low radioactivity fraction of high-level waste from the in-tank precipitation process mixed with cement, flyash, and slag to form a concrete block.

**Sandstone:** A sedimentary rock predominantly containing individual mineral grains visible to the unaided eye.

**Sanitary wastes:** Wastes generated by normal housekeeping activities, liquid or solid (includes sludge), which are not hazardous or radioactive.

**Sanitization:** An irreversible modification or destruction of a component or part of a component to the extent required to prevent revealing classified or otherwise controlled information.

**Schist:** Crystalline metamorphic rock formed by dynamic metamorphism that can be split easily into thin slabs or flakes.

**Scintillation:** Minute flash of light caused when alpha, beta, or gamma rays strike certain phosphors.

**Scope:** In a document prepared pursuant to the National Environmental Policy Act of 1969, the range of actions, alternatives, and impacts to be considered.

**Secondary system:** The system that circulates a coolant (water) through a heat exchanger to remove heat from the primary system.

**Sedimentation:** The settling out of soil and mineral solids from suspension in water.

**Seepage basin:** An unlined excavation in the ground that receives aqueous effluent.

**Seismic:** Pertaining to any earth vibration, especially an earthquake.

**Seismic zone:** An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern U.S.); (4) Zone 2B - slightly more damage than 2A (western U.S.); (5) Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.

**Seismicity:** The tendency for the occurrence of earthquakes.

**Severe accident:** An accident with a frequency rate of less than $10^{-6}$ per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both.

**Sewage:** The total of organic waste and wastewater generated by an industrial establishment or a community.

**Short-lived activation products:** An element formed from neutron interaction that has a relatively short half-life and which is not produced from the fission reaction (e.g., a cobalt isotope formed from impurities in the metal of the reactor piping).

**Short-lived nuclides:** Radioactive isotopes with half-lives no greater than about 30 years (e.g., cesium-137 and strontium-90).

**Shrink-swell potential:** Refers to the potential for soils to contract while drying and expand after wetting.

**Shutdown:** For a Department of Energy reactor, that condition in which the reactor has ceased operation and the Department has declared officially that it does not intend to operate it further (see DOE Order 5480.6, *Safety of Department of Energy-Owned Nuclear Reactors*).

**Silica:** Silicon dioxide, a common mineral that occurs naturally as quartz.

**Silt:** A sedimentary material consisting of fine mineral particles intermediate in size between sand and clay.

**Siltstone:** A sedimentary rock composed of fine textured minerals.

**Socioeconomic baseline characterization:** A description and discussion of the social and economic characteristics of a study area, including a profile of local government, housing supply, land use, and public and private services.

**Source term:** The estimated quantities of radionuclides or chemical pollutants released to the environment.

**Spallation:** Any nuclear reaction when several particles result from a collision, e.g., chain-reaction in a nuclear reactor.

**Special nuclear materials:** As defined in Section 11 of the Atomic Energy Act of 1954, special nuclear material means (1) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Nuclear Regulatory Commission determines to be special nuclear material or (2) any material artificially enriched by any of the foregoing.

**Standardization (Epidemiology):** Techniques used to control the effects of differences (e.g., age) between populations when comparing disease experience. The two main methods are:

- Direct method, in which specific disease rates in the study population are averaged, using as weights the distribution of the comparison population.
- Indirect method, in which the specific disease rates in the comparison population are averaged, using as weights the distribution of the study population.

**Standby:** That condition in which a reactor facility is neither operable nor declared excess and in which documentary authorization exists to maintain the reactor for possible future operation (DOE Order 5480.6).

**Steppe:** An area of grass-covered and generally treeless plains.

**Steppe climate (semiarid climate):** The type of climate in which precipitation is very slight but sufficient for the growth of short, sparse grass.

**Storativity:** The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of head (fluid pressure plus elevation) normal to the surface.

**Stratigraphy:** Division of geology dealing with the definition and description of rocks and soils, especially sedimentary rocks.

**Strike:** The direction or trend that a structural surface (e.g., a bedding or fault plane) takes as it intersects the horizontal.

**Strike-slip movement:** Movement along a fault surface where the movement is horizontal and parallel to the strike of the fault.

**Sulfur oxides:** Common air pollutants, primarily sulfur dioxide ($SO_2$), a heavy pungent, colorless gas (formed in the combustion of coal), which is considered a major air pollutant, and sulphur trioxide ($SO_3$).

**Superfund Amendments and Reauthorization Act of 1986:** In addition to certain free-standing provisions of law, it includes amendments to Compensation Environmental Response, Compensation, and Liability Act of 1980 and the Safe Drinking Water Act.

**Surface water:** Water on the Earth's surface, as distinguished from water in the ground (groundwater).

**Surplus facility:** Any facility or site (including installed equipment) that has no identified programmatic use or that may or may not be radioactively contaminated to levels that require controlled access.

**Technical safety appraisal:** A documented, multidisciplined appraisal of selected Department of Energy reactors and nuclear facilities conducted by a team selected by the Department of Energy's Deputy Assistant Secretary for Safety, Health, and Quality Assurance. It ensures proper application of particular safety elements of the Department of Energy's environment, safety, and health program, nuclear industry lessons learned, and appropriate licensed facility requirements as described in DOE 5482.1B (9b), *Environment, Safety, and Health Appraisal Program.*

**Technology development program:** An Office of the Assistant Secretary for Environmental Management subprogram that includes establishing and maintaining an aggressive national program for applied research, development, demonstration, testing, and evaluation to resolve major environmental restoration and waste management technology deficiencies by rapidly advancing technology beyond current capabilities.

**Tectonic plate:** One of the massive rigid plates that together form the Earth's lithosphere, or outermost layer (crust).

**Tertiary:** The first geologic period of the Cenozoic Era, dating from 66 million to about 3 million years ago. During the Tertiary, mammals became the dominant life form.

**Thermal desorption:** The heating of waste to a point where volatile liquid contaminants can be driven off, and either condensing the vapors or absorbing them on activated carbon. Often used to drive off residual liquid prior to waste compaction. If the waste is mixed low-level due to the presence of organic solvents, thermal desorption removes the hazardous constituents, leaving a low-level waste.

**Thermoluminescent dosimeter:** A radiation detection device that accumulates a dose or exposure over a period of time.

**Third Thirds waste:** The Environmental Protection Agency proposed the Third Thirds Rule, as required by the Hazardous and Solid Waste Amendments of 1984, to establish treatment standards and effective dates for all wastes (including characteristic wastes) for which treatment standards had not yet been promulgated (40 CFR 268.12), including derived-from wastes (i.e., multi-source leachage), and for mixed radioactive/hazardous wastes.

**Threatened species:** Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

**Threshold limit values:** The recommended concentrations of contaminants workers may be exposed to according to the American Council of Governmental Industrial Hygienists.

**Title I design (preliminary design):** Continues a design effort using the conceptual design and the project design criteria as a basis for project development. Title I design develops topographical and subsurface data and determines the requirements and criteria that will govern the definitive design. Tasks include preparation of preliminary planning and engineering studies, preliminary drawings and outline specifications, life-cycle cost analysis, preliminary cost estimates, and scheduling for project completion. Preliminary design identifies long-lead-time procurement items and analyzes risks associated with continued project development.

**Title II design (definitive design):** Continues the development of a project based on an approved preliminary design (Title I). Definitive design includes any revisions of the Title I effort; preparation of final working drawings, specifications, bidding documents, and cost estimates; coordination with all parties that might affect the project; development of firm construction and procurement schedules; and assistance in analyzing proposals or bids.

**Title III inspection (concurrent with construction):** Complete architectural and engineering supervision and inspection of construction under the direction of a responsible representative. Includes checking of shop drawings and furnishing of reproducible "as-built" record drawings and marked-up

specifications showing construction as actually accomplished.

**Toxic Substances Control Act of 1976:** This Act authorizes the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.

**Transients:** Events that could cause the temporary production of more (or less) heat in the reactor than the cooling system; also called reactivity change or power transients.

**Transmissivity:** A measure of a water-bearing unit's capacity to transmit fluid: the product of the thickness and the average hydraulic conductivity of a unit. Also, the rate at which water is transmitted through a strip of an aquifer of a unit width under a unit hydraulic gradient at a prevailing temperature and pressure.

**Transportation and emergency management program:** The transportation program is responsible for the safe movement of wastes among facilities for the purposes of treatment, storage, and disposal. The emergency management program is responsible for coordinating the response to adverse occurrences in environmental restoration and waste management operations.

**Transuranic waste:** Waste contaminated with alpha-emitting radionuclides with half-lives greater than 20 years and concentrations greater than 100 nanocuries/gram at time of assay. It is not a mixed waste.

**Triassic:** First period of the Mesozoic Era, dating from between 245 to 208 million years ago.

**Tritium:** A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for the isotope are H-3 and T.

**Unconfined aquifer:** A permeable geological unit having the following properties: a water-filled pore space (saturated), the capability to transmit significant quantities of water under ordinary differences in pressure, and an upper water boundary that is at atmospheric pressure.

**Undue risk:** A level of risk to the health and safety of the public that exceeds that set forth in the design and operation objectives of the facility.

**Unreviewed safety question:** A proposed change, test, or experiment is considered to involve an unreviewed safety question if (1) the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety evaluated previously by safety analyses will be significantly increased or (2) a possibility for an accident or malfunction of a different type than any evaluated previously by safety analyses will be created that will result in significant safety consequences.

**Unsaturated zone (vadose):** A region in a porous medium in which the pore space is not filled with water.

**Unusual occurrence:** Any unusual or unplanned event that adversely affects or potentially affects the performance, reliability, or safety of a facility.

**Upset condition:** For a nuclear facility, anticipated occurrences of moderate frequency that might occur several times during start-up testing or operation of the facility. The equipment, components, and structures must withstand these conditions without damage requiring repair. For American Society of Mechanical Engineers code pressure boundary components, this plant design condition corresponds to the "Level B Service Limits". (Also, see "emergency condition" and "faulted condition.")

**Uranium:** A heavy, silvery-white metallic element (atomic number 92) with many radioactive isotopes. Uranium-235 is most commonly used as a fuel for nuclear fission. Another isotope, uranium-238, is transformed into fissionable plutonium-239 following its capture of a neutron in a nuclear reactor.

**Viewshed:** The extent of the area that may be viewed from a particular location. Viewsheds are generally bounded by topographic features such as hills or mountains.

**Visual Resource Management Class:** A class defines the different degrees of modification allowed to the basic elements of landscape. They are Class 1–applied to wilderness areas, wild and scenic rivers, and other similar situations; Class 2–contrasts are seen but do not attract attention; Class 3–contrasts caused by a cultural activity are evident, but remain subordinate to the existing landscape; Class 4–contrasts that attract attention and are dominant features of the landscape in terms of scale, but repeat the contrast of the characteristic landscape; Class 5–applied to areas where unacceptable cultural modification has lowered scenic quality (where the natural character of the landscape has been disturbed to a point where rehabilitation is needed to bring it up to one of the four other classifications).

**Visual sensitivity level:** The relative degree of viewer numbers, visibility of the subject landscape and the degree of potential viewer interest, concern, and attitude for existing or proposed changes in the landscape character.

**Vitrification:** A waste treatment process that uses glass (e.g., borosilicate glass) to encapsulate or immobilize radioactive wastes to prevent them from reacting in disposal sites.

**Volatile organic compounds:** A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, chloroform, and methyl alcohol.

**Waste Isolation Pilot Plant:** A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

**Water quality standard and criteria:** Concentration limit of constituents or characteristics allowed in water; often based on water use classifications (e.g., drinking water, recreation use, propagation of fish and aquatic life, and agricultural and industrial use). Water quality standards are legally enforceable: water quality criteria are non-enforceable recommendations based on biotic impacts.

**Water table:** Water under the surface of the ground occurs in two zones, an upper unsaturated zone and the deeper saturated zone. The boundary between the two zones is the water table.

**Weapons-grade:** Fissionable material in which the abundance of fissionable isotopes is high enough that the material is suitable for use in thermonuclear weapons.

**Weighting factor:** Represents the fraction of the total health risk resulting from uniform whole-body irradiation that could be contributed to that particular tissue.

**Wetland:** Land or areas exhibiting hydric soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions.

**Wet site:** For the purposes of this Programmatic Environmental Impact Statement, any site where adequate water is available for evaporative cooling of tritium supply technologies.

**Whole-body dose:** Dose resulting from the uniform exposure of all organs and tissues in a human body. (Also, see "effective dose equivalent.")

**Wind rose:** A depiction of wind speed and direction frequency for a given period of time.

**X/Q (Chi/Q):** The relative calculated air concentration due to a specific air release; units are (sec/m3). For example, (Ci/m3)/(Ci/sec)=(sec/m3) or (gm/m3)(gm/sec)=(sec/m3).

**Zircaloy-4:** An alloy of zirconium metal frequently used in nuclear reactors because of its desirable chemical and nuclear properties.

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DOE/EIS-0161

# Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling

## Volume II

DOE/EIS 0161

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Office of Reconfiguration

February 1995

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# Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling

## Volume II

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# Acronyms, Abbreviations, and Conversion Charts

# Acronyms, Abbreviations, and Conversion Charts

## Acronyms and Abbreviations

| | |
|---|---|
| APT | Accelerator Production of Tritium |
| ALWR | Advanced Light Water Reactor |
| AQCR | Air Quality Control Region |
| CAA | *Clean Air Act* |
| CEQ | Council on Environmental Quality |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act* |
| CFR | Code of Federal Regulations |
| CWA | *Clean Water Act* |
| D&D | decontamination and decommissioning |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOI | Department of the Interior |
| DOT | Department of Transportation |
| DP | DOE Office of the Assistant Secretary for Defense Programs |
| EA | environmental assessment |
| EIS | environmental impact statement |
| EM | DOE Office of the Assistant Secretary for Environmental Management |
| EPA | Environmental Protection Agency |
| ES&H | environment, safety, and health |
| HAP | hazardous air pollutants |
| HE | high explosive(s) |
| HEPA | high efficiency particulate air |
| HEU | highly enriched uranium |
| HI | Hazard Index |
| HLW | high-level waste |
| HQ | Hazard Quotient |
| HWR | Heavy Water Reactor |
| INEL | Idaho National Engineering Laboratory |
| IP | implementation plan |
| $L_{eq}$ | equivalent sound level |
| LLW | low-level waste |
| MHTGR | Modular High Temperature Gas-Cooled Reactor |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | *National Environmental Policy Act* of 1969 |
| NESHAP | National Emissions Standards for Hazardous Air Pollutants |
| NOI | Notice of Intent |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| NRHP | National Register of Historic Places |
| NTS | Nevada Test Site |
| ORNL | Oak Ridge National Laboratory |

| | |
|---|---|
| ORR | Oak Ridge Reservation |
| OSHA | Occupational Safety and Health Administration |
| PEIS | programmatic environmental impact statement |
| $PM_{10}$ | particulate matter of aerodynamic diameter less than 10 micrometers |
| RCRA | *Resource Conservation and Recovery Act* |
| ROD | Record of Decision |
| ROI | region-of-influence |
| SAR | Safety Analysis Report |
| SARA | *Superfund Amendments and Reauthorization Act* |
| SDWA | *Safe Drinking Water Act* |
| SHPO | State Historic Preservation Officer |
| SRS | Savannah River Site |
| START | Strategic Arms Reduction Treaty |
| TOC | total organic compounds |
| TRU | transuranic |
| TSCA | *Toxic Substances Control Act* |
| TSP | total suspended particulates |
| TSS | tritium supply site |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| VOC | volatile organic compounds |
| VRM | Visual Resource Management |
| WIPP | Waste Isolation Pilot Plant |

## Chemicals and Units of Measure

| | |
|---|---|
| BGY | billion gallons per year |
| Ci | Curie |
| $CC1_4$ | carbon tetrachloride |
| CO | carbon monoxide |
| CFC | chlorofluorocarbons |
| dB | decibel |
| dBA | decibel A-weighted |
| DCE | 1, 2-dichlororethylene |
| F | Fahrenheit |
| $ft^2$ | square feet |
| $ft^3$ | cubic feet |
| $ft^3/s$ | cubic feet per second |
| g | gram |
| gal | gallon |
| GPD | gallons per day |
| gpm | gallons per minute |
| GPY | gallons per year |
| HCFC-22 | chlorodifluoromethane |
| HMX | cyclotetramethylenetetranitramine or 1, 3, 5, 7-tetranitro-1, 3, 5, 7-tetrazocine |
| hr | hour |
| kg | kilogram |
| kV | kilovolt |
| kVA | kilovolt-ampere |
| kW | kilowatt |
| kWh | kilowatt hour |
| lb | pound |
| lb/hr | pounds per hour |
| lb/yr | pounds per year |
| Li | lithium |
| mCi | millicurie (one-thousandth of a Curie) |
| mCi/ml | millicurie per milliliter |
| mg | milligram (one-thousandth of a gram) |
| mg/l | milligram per liter |
| MGD | million gallons per day |
| MGY | million gallons per year |
| mrem | millirem (one-thousandth of a rem) |
| MVA | megavolt-ampere |
| MW | megawatt |
| MWe | megawatt electric |
| MWh | megawatt hour |
| MWt | megawatt thermal |
| nCi | nanocurie (one-billionth of a Curie) |

| | |
|---|---|
| nCi/g | nanocuries per gram |
| $NO_2$ | nitrogen dioxide |
| $NO_X$ | nitrogen oxides |
| $O_3$ | ozone |
| Pb | lead |
| PCB | polychlorinated biphenyl |
| pCi | picocurie (one-trillionth of a Curie) |
| pCi/l | picocuries per liter |
| PETN | pentaerythritoltetranitrate |
| ppb | parts per billion |
| ppm | parts per million |
| Pu | plutonium |
| RDX | cyclotrimethylenetrinitramine |
| rem | roentgen equivalent man |
| $SO_2$ | sulfur dioxide |
| TATB | triaminotrinitrobenzene |
| TCA | 1, 1, 1-trichloroethane |
| TCE | trichloroethylene |
| TNT | trinitrotoluene |
| U | uranium |
| $yd^3$ | cubic yards |
| μCi | microcurie (one-millionth of a Curie) |
| μCi/g | microcuries per gram |
| μg | microgram (one-millionth of a gram) |
| μg/kg | micrograms per kilogram |
| μg/l | micrograms per liter |
| $\mu g/m^3$ | micrograms per cubic meter |
| μm | micron or micrometer (one-millionth of a meter) |

## Metric Conversion Chart

| To Convert Into Metric | | | To Convert Out of Metric | | |
|---|---|---|---|---|---|
| **If You Know** | **Multiply By** | **To Get** | **If You Know** | **Multiply By** | **To Get** |
| **Length** | | | | | |
| inches | 2.54 | centimeters | centimeters | 0.3937 | inches |
| feet | 30.48 | centimeters | centimeters | 0.0328 | feet |
| feet | 0.3048 | meters | meters | 3.281 | feet |
| yards | 0.9144 | meters | meters | 1.0936 | yards |
| miles | 1.60934 | kilometers | kilometers | 0.6214 | miles |
| **Area** | | | | | |
| sq. inches | 6.4516 | sq. centimeters | sq. centimeters | 0.155 | sq. inches |
| sq. feet | 0.092903 | sq. meters | sq. meters | 10.7639 | sq. feet |
| sq. yards | 0.8361 | sq. meters | sq. meters | 1.196 | sq. yards |
| acres | 0.40469 | hectares | hectares | 2.471 | acres |
| sq. miles | 2.58999 | sq. kilometers | sq. kilometers | 0.3861 | sq. miles |
| **Volume** | | | | | |
| fluid ounces | 29.574 | milliliters | milliliters | 0.0338 | fluid ounces |
| gallons | 3.7854 | liters | liters | 0.26417 | gallons |
| cubic feet | 0.028317 | cubic meters | cubic meters | 35.315 | cubic feet |
| cubic yards | 0.76455 | cubic meters | cubic meters | 1.308 | cubic yards |
| **Weight** | | | | | |
| ounces | 28.3495 | grams | grams | 0.03527 | ounces |
| pounds | 0.45385 | kilograms | kilograms | 2.2034 | pounds |
| short tons | 0.90718 | metric tons | metric tons | 1.1023 | short tons |
| **Temperature** | | | | | |
| Fahrenheit | Subtract 32 then multiply by 5/9ths | Celsius | Celsius | Multiply by 9/5ths, then add 32 | Fahrenheit |

## Metric Prefixes

| Prefix | Symbol | Multiplication Factor |
|---|---|---|
| exa- | E | 1 000 000 000 000 000 000 = $10^{18}$ |
| peta- | P | 1 000 000 000 000 000 = $10^{15}$ |
| tera- | T | 1 000 000 000 000 = $10^{12}$ |
| giga- | G | 1 000 000 000 = $10^{9}$ |
| mega- | M | 1 000 000 = $10^{6}$ |
| kilo- | k | 1 000 = $10^{3}$ |
| hecto- | h | 100 = $10^{2}$ |
| deka- | da | 10 = $10^{1}$ |
| deci- | d | 0.1 = $10^{-1}$ |
| centi- | c | 0.01 = $10^{-2}$ |
| milli- | m | 0.001 = $10^{-3}$ |
| micro- | µ | 0.000 001 = $10^{-6}$ |
| nano- | n | 0.000 000 001 = $10^{-9}$ |
| pico- | p | 0.000 000 000 001 = $10^{-12}$ |
| femto- | f | 0.000 000 000 000 001 = $10^{-15}$ |
| atto- | a | 0.000 000 000 000 000 001 = $10^{-18}$ |

# APPENDIX A

# Appendix A

# APPENDIX A: NUCLEAR FACILITIES

The Nuclear Weapons Complex (Complex) is comprised of facilities located at 11 major U.S. Department of Energy (DOE) sites, distributed over 10 states. Summary descriptions of the Complex sites considered for tritium supply and recycling are presented in chapters 1, 3, and 4. This appendix examines in more detail four Complex sites and one other, the Idaho National Engineering Laboratory (INEL), which is being considered as a potential addition to the Complex.

The five DOE sites described in appendix A include INEL, the Nevada Test Site (NTS), the Oak Ridge Reservation (ORR), the Pantex Plant, and the Savannah River Site (SRS). The first section of this appendix provides detailed reference operation assumptions for each site examined in this PEIS. Information provided includes specific site location descriptions, current missions, facility operations, and environmental regulatory compliance activities associated with ongoing DOE Office of the Assistant Secretary for Defense Programs (DP), other DOE, and non-DOE programs.

The next section of this appendix is divided into two parts. First is the detailed description of the tritium supply technologies. This is followed by a detailed description of the tritium recycling facilities which could be either new collocated facilities or, in the case of SRS, upgrade modifications to existing facilities. Each description includes specific information describing missions, assumptions, functional parameters, expected capabilities, process descriptions, special process requirements, utilities, chemicals used, operational resources, transportation, and environmental regulatory setting. The final section discusses tritium supply technology options which are outside the scope of this Programmatic Environmental Impact Statement (PEIS).

## A.1 Reference Operating Assumptions

The reference case for the Tritium Supply and Recycling PEIS is No Action, which was previously described in section 3.2.1. No Action allows a comparison of tritium supply alternatives for the candidate sites, not against the current nuclear weapons facility configuration, but against the configuration as it would be expected to operate in 2010 and beyond.

No Action assumes that all nuclear sites of the current Complex would continue their current missions only with existing facilities that can comply with environment, safety, and health (ES&H) requirements, and at a level that is consistent with current DOE guidance. The basic missions assigned to the sites include the following: research, development, and testing; maintaining nuclear weapons production and testing capability; processing and storage of nuclear materials; operation of an extensive transportation safeguards system to assure the safe, secure movement of weapons and strategic quantities of nuclear materials within the continental United States; non-weapon projects; energy programs; and, cooperation with the Department of Defense (DOD) in responding to nuclear accidents or incidents throughout the world.

Under No Action, the siting and construction of a new tritium supply facility would not occur, there would be no upgrades/modifications of existing facilities, and future support of the nuclear weapons stockpile would be provided within the confines of the existing Complex capabilities. Some mission requirements for maintenance of the weapons stockpile in the future would not be met under No Action. However, No Action includes those mission requirements to represent a reference against which tritium supply and recycling alternatives that would meet the Department's *Atomic Energy Act* responsibilities could be compared.

Sites would continue waste management programs to meet the legal requirements and commitments in formal agreements and would proceed with cleanup activities. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for the year 2010 and beyond.

Detailed reference descriptions of the affected nuclear sites follows. These descriptions include discussion of the site location, missions, facility operations, and environmental regulatory compliance.

### A.1.1 Idaho National Engineering Laboratory

**Site Description.** INEL is located in 4 counties and covers 890 square miles in southeastern Idaho near Idaho Falls. The main site is 34 miles west of Idaho Falls, 38 miles northwest of Blackfoot, and 22 miles east of Arco. There is also an annex in Idaho Falls. The facility covers more than 569,000 acres with approximately 277 miles of roads, both paved and unpaved, and 30 miles of railroad track (figure 4.2.1–1 and table 4.2.2.2–1).

There are 450 buildings and 2,000 support structures at INEL with more than 3 million square feet ($ft^2$) of floor space in varying conditions of utility. INEL has approximately 270,000 $ft^2$ of covered warehouse space and an additional 200,000 $ft^2$ of fenced yard space. The total area of the various machine shops is 32,665 $ft^2$. The majority of experiment sites are no longer in use and are scheduled for decontamination and decommissioning (D&D) and restoration. There are three reactors operating continuously and eight sites that formerly housed reactors, now scheduled for D&D.

Warehouses are located in all onsite areas and, on average, are filled to more than 85 percent of capacity. Also, there are 11 machine shops on the site to support all activities. Besides the main site, there is also an INEL annex in Idaho Falls which has office buildings, a computer center, and a research and development laboratory where site related technical, analytical, and administrative activities are conducted.

Four separate management and operations contractors operate the Idaho Chemical Processing Plant, the Naval Reactor Facility, Argonne National Laboratory-West, and the remainder of the site for DOE. Transportation to and from INEL is provided to all persons employed onsite. There are no long-term housing facilities at INEL. INEL procures more than $25 million worth of material, supplies, and construction services in the region per year.

**Missions.** The missions of INEL are:

- Provide waste management functions.
- Perform waste processing, technology research and development.
- Perform research on reactor safety operations, materials testing and environmental monitoring.
- Perform breeder reactor irradiation tests.
- Perform irradiation service, develop nuclear instruments, and perform geological and defense research.
- Maintain a standby facility for conducting ship propulsion reactor research and training.

**Facility Operations.** Activities at INEL have been divided among nine distinct and geographically separate functional areas (table 3.3.2–1).

- Fuel reprocessing activities at the Idaho Chemical Processing Plant have been terminated and operations are focused on spent fuel storage and high-level waste processing.
- The Radioactive Waste Management Complex is a storage and disposal facility intended primarily for radioactive materials from defense and nuclear energy research programs. The Complex consists of three main areas: an 88-acre subsurface disposal area, a 56-acre transuranic storage area, and an administrative area.
- The Power Burst Facility supports research and development for waste reduction programs. A reactor used for thermal fuels behavior studies is now in a standby mode. Major waste reduction facilities include the Waste Engineering Development Facility, the Waste Experimental Reduction Facility, and the Mixed Waste Storage Facility.
- The Test Area North complex is the northernmost facility within INEL and consists of several experimental reactor and support facilities conducting research and development activities on reactor performance. These include the Technical Support Facility, the Contain-

ment Test Facility, the Water Reactor Research Test Facility, and the Inertial Engine Test Facility. The Inertial Engine Test Facility has been abandoned with no future programs planned. The remaining facilities support ongoing programs that are expected to continue for the foreseeable future.

- The Auxiliary Reactor Area is the site where materials testing and environmental monitoring activities are conducted. The facilities in this area are scheduled for D&D.

- The Argonne National Laboratory-West is dedicated to breeder reactor development.

- The Test Reactor Area supports the Advanced Test Reactor which is used for irradiation testing of fuel, core materials, and instrumentation for naval reactors. Wastes from this facility are handled by the Radioactive Waste Management Complex.

- The Naval Reactors Facility is operated for DOE and U.S. Navy by Westinghouse Electric Corporation under jurisdiction of DOE's Pittsburgh Naval Reactors Office. Activities include the testing of advanced design equipment and new systems for current naval nuclear power propulsion plants and obtaining data for future design.

- The Central Facilities Area provides effective site-wide support services including transportation, shop services, health services, radiation monitoring, and administrative offices.

*Defense Program Activities.* There are no defense program activities currently being performed at INEL.

*Other Department of Energy Activities.* The Test Area North is used for light water reactor safety tests and specific manufacturing. The Naval Reactor Facility contains four reactors (scheduled for shutdown by June 1995) where new designs are tested: the Submarine Prototype (S1W), the Large Ship Reactor (A1W), the Natural Circulation Submarine Prototype (S5G), and the Expended Core Facility. At the Test Reactor Area, the Advanced Test Reactor is currently operating to test reactor fuel, targets, core materials, and electronics. The Engineering Test Reactor and the Materials Test Reactor are in standby and the buildings are used for offices and test laboratories. The Auxiliary Reactor Area is being utilized for materials testing, but is scheduled for D&D in the near future. The Power Burst Facility reactor is on standby, but the area is used for low-level waste (LLW) engineering and development and for mixed waste storage. Argonne National Laboratory-West operates an Experimental Breeder Reactor for research and development. The Radioactive Waste Management Complex is used for examination and certification of INEL wastes. It also provides for storage of retrievable transuranic (TRU) wastes and disposal of low-level radioactive (beta-gamma) waste. The Central Facilities Area provides support services for the entire site. There are a variety of support and service organizations onsite. These include the facilities to handle security, fire protection, facilities service and maintenance, food preparation, mail, transportation, medical, communication, warehousing, and machine shops.

*Non-Department of Energy Activities.* There are non-DOE activities at INEL which include research being conducted by the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and various institutions of higher learning. These activities support the designation of INEL as a National Environmental Research Park.

**Environmental Regulatory Setting.** The Environmental Oversight and Monitoring Agreement between DOE and the State of Idaho, signed May 21, 1990, was developed to assure the citizens of Idaho that their health and safety and the environment are being protected. This voluntary agreement addresses understandings and commitments between the parties regarding DOE's provision to the State of Idaho of technical and financial support for state activities to assess compliance with applicable laws and regulations at INEL. These activities consist of environmental oversight, monitoring, and evaluations of emergency response plans. The independent monitoring includes onsite discharges, groundwater

and air quality, and offsite radioactivity, as well as evaluation of waste minimization planning and source reduction methods. This agreement has been extended until negotiations for a new agreement are completed and approved. Negotiations begin in the fall of 1994 and are expected to conclude in 1995.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at INEL. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

On December 21, 1989, EPA placed INEL on the National Priorities List (NPL) as a "Superfund Site" pursuant to the provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA). This determination was based on the contamination present due to past practices.

*Air.* The INEL air emission inventory, completed in March 1991, catalogs all vents and stacks at INEL. The air toxics inventory for radioactive and other hazardous air pollutants is being compiled and, when added to the air emissions inventory, will serve as the basis for the operating permits required under Title V of the *Clean Air Act* (CAA) *Amendments* of 1990. INEL is in full compliance with *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H), with an effective dose equivalent to the public for 1991 at 0.004 millirem (mrem) per year (IN DOE 1992d:34).

The Idaho Operations Office signed a Consent Order on February 11, 1992, with the State of Idaho whereby INEL agreed to pay a monetary penalty and to apply for the appropriate air quality permit for the construction and operation of potential air pollution sources. A Notice of Violation issued in June 1991 alleged these facilities had been constructed without the required permits.

In addition to the Notice of Violation, there has been litigation over the need for an air quality permit for the storage of the Fort St. Vrain spent nuclear fuel at the Idaho Chemical Processing Plant-Building 603 Facility. The June 28, 1993, decision of the U.S. District Court for the District of Idaho barred any further transportation, receipt, processing, or storage of spent nuclear fuel at INEL until all requirements of *National Environmental Policy Act* of 1969, (NEPA) are met. The decision came in a suit filed in 1991 in the case of *Public Service Company of Colorado* v. *Cecil Andrus* (Governor of Idaho), Docket No. 91-0035-S-HLR, and *United States* v. *Cecil Andrus*, Docket No. 91-00540S-HLR. DOE and Public Service Company of Colorado sued the Governor of Idaho who had prevented the Public Service Company of Colorado from shipping spent nuclear fuel from the Fort St. Vrain reactor to INEL. The court ordered DOE to prepare a comprehensive environmental impact statement (EIS) on all major Federal actions involving the transportation, receipt, processing, and storage of spent nuclear fuel at INEL. This order also halted shipments of spent nuclear fuel to INEL until the EIS is completed. As a result of this order, DOE, the U.S. Navy, and the State of Idaho reached the Idaho Agreement on August 9, 1993. The Idaho Agreement encompasses the transportation, receipt, processing, and storage of spent nuclear fuel at INEL. This agreement is a negotiated settlement among the parties to satisfy the U.S. District Court's June 28 decision. Under the terms of this agreement, DOE agrees to complete not later than April 30, 1995, an EIS on transportation, receipt, processing, and storage of spent nuclear fuel at INEL. DOE also agrees to halt further shipments of spent nuclear fuel to INEL except for 19 naval spent nuclear fuel shipments specified in the agreement until after a decision supported by the EIS is made.

*Water.* The Snake River Plain aquifer, a sole source aquifer which lies beneath INEL, serves as the source for drinking water and crop irrigation in the Snake River Basin. Natural radioactivity is found in the Snake River Plain aquifer in areas upgradient, parallel to, and distant from INEL. Onsite and offsite water samples are collected routinely to monitor the movement of waste substances, both radioactive and nonradioactive, through the aquifer onsite. Onsite drinking water samples are collected monthly from production drinking water wells in use at active site facilities. Approximately 25 percent of all drinking water samples collected in 1991, contained detectable concentrations of gross alpha activity.

The Idaho Operations Office submitted applications to the State of Idaho for two National Pollutant Discharge Elimination System (NPDES) permits in January 1992. These permit requests are for discharges of noncontact cooling water and for discharges of wastewater to the Big Lost River from the Idaho Chemical Processing Plant. No other INEL facility discharges liquid effluents to surface waters other than stormwater, and no streams or rivers flow from within INEL to locations outside the boundaries. In addition to the two NPDES permits, INEL has filed nine deep injection well permit applications with the State of Idaho. The injection wells are used to dispose of stormwater runoff. DOE continues to update the inventory of shallow injection wells.

On October 7, 1992, the Idaho Operations Office signed a Consent Order with the State of Idaho to settle the Notice of Violation issued on June 7, 1991, for alleged violation of Idaho water quality regulations. The Notice of Violation alleges that the Idaho Operations Office is subject to a state permit program for systems treating wastewater by application to the land via percolation ponds and unlined sewage systems at the Idaho Chemical Processing Plant. DOE will obtain stormwater discharge permits under NPDES. Also, draft wastewater land application permits have been issued and are currently being negotiated. INEL is currently covered under two general permits: stormwater discharges associated with industrial activity and construction activity.

*Land. The Idaho Hazardous Waste Management Act* and EPA delegation of authority to the state provides the Idaho Department of Health and Welfare authority to enforce hazardous waste management regulations and to provide oversight of *Resource Conservation and Recovery Act* (RCRA) related environmental restoration activities. INEL has an approved RCRA Part A treatment, storage, and disposal permit and has submitted for approval the RCRA Part B permit application.

In 1989, the Governor of the State of Idaho placed a moratorium on the receipt of TRU wastes from out-of-state. INEL is honoring the governor's moratorium even though solid radioactive wastes from Rocky Flats Environmental Technology Site (formerly known as the Rocky Flats Plant) have been received and buried at INEL since 1954. Offsite generators, including the Rocky Flats Environmental Technology Site and the Mound Plant, which had been approved to make routine waste shipments to the Radioactive Waste Management Complex at INEL, are adversely affected. INEL has also agreed to terminate TRU waste disposal activities on INEL. TRU waste not buried prior to this agreement is being stored at the Radioactive Waste Management Complex in compliance with applicable regulatory requirements, awaiting permanent disposal at a Federal repository.

Three areas of confirmed releases of contamination to the environment at INEL have been identified:

- The Radioactive Waste Management Complex, where small amounts of volatile organic compounds have been measured in the groundwater aquifer and trace concentrations of TRU radionuclides were detected at a 110-foot depth above the aquifer. Both contaminants are suspected to be traceable to buried TRU waste. Additional contaminants that potentially may be released include petroleum products, acids, bases, volatile organic compounds, heavy metals, radionuclides, polychlorinated biphenyls (PCBs), and asbestos.

- The Test Reactor Area, where chromium compounds have been detected beneath a wastewater pond in groundwater that is perched above the Snake River Plain aquifer. Remedial action is underway.

- The Test Area North groundwater, where volatile organic compounds were measured in wells that supply drinking water. Remedial action is underway.

DOE entered into a Federal Facility Agreement and Consent Order with EPA and the State of Idaho. The agreement, signed December 9, 1991, meets the requirement of Section 120(e) of CERCLA (42 U.S.C. § 9601 *et seq.*) for an interagency agreement with EPA for Federal agencies that have facilities included on the NPL. The Federal Facility Agreement and Consent Order is implemented by an Action Plan outlining the remedial action process, which will encompass investigation of hazardous substances and cleanup activities at INEL.

The purposes of the Federal Facility Agreement and Consent Order Action Plan are to:

- Establish a procedural framework and schedule for developing and monitoring appropriate response actions at INEL in accordance with CERCLA, RCRA, and the Idaho *Hazardous Waste Management Act.*

- Facilitate cooperation, exchange of information, and participation of the parties in such actions.

- Minimize duplication of analyses and documentation.

- Expedite the clean-up process to the maximum extent possible consistent with protection of human health and the environment.

- Supersede the existing RCRA 3008(h) Consent Order and Compliance Agreement executed on July 10, 1987.

In February 1990, INEL received a Notice of Noncompliance issued by EPA on January 29, 1990, for 28 alleged violations of RCRA regulations based on a June 5 to 9, 1989, inspection. The majority of violations have been resolved and long-term technical solutions for the Radioactive Waste Management Complex and Idaho Chemical Processing Plant have been agreed upon. On April 3, 1992, the Idaho Operations Office, the State of Idaho, and EPA Region 10 signed a Consent Order to settle the unresolved issues from the 1990 Notice of Noncompliance. The sodium in Building 703 (1,400 55-gallon drums) at the Argonne National Laboratory-West site has been declared a waste. DOE has agreed to manage the sodium in Building 703, "...in compliance with all applicable interim status provisions of the *Hazardous Waste Management Act* and the Rules, Regulations and Standards for Hazardous Waste..." (IN DOE 1993a:124). The Consent Order sets up a schedule for corrective actions to be taken in the management of radioactive sodium bearing liquid wastes currently stored at the Idaho Chemical Processing Plant in the tanks with concrete vault secondary containment. Because the concrete vaults would react with the acidic solutions stored in the tanks, they do not meet RCRA requirements for secondary containment of hazardous wastes. The corrective actions at the Radioactive Waste Management Complex, Argonne National Laboratory-West, and the Idaho Chemical Processing Plant could take more than 25 years.

On October 7, 1992, the Idaho Operations Office signed another Consent Order with the State of Idaho to resolve the Hazardous Waste Notice of Violation issued by the state on June 5, 1991, for 23 alleged hazardous waste violations identified during the September 10 to 14, 1990, inspection. This Consent Order provides the schedule for corrective actions such as establishing satellite accumulation areas, closure of the Idaho Chemical Processing Plant percolation ponds, and discontinuing the discharge of non-RCRA wastewater into the percolation ponds prior to formal "clean" closure. Completion of these actions will resolve this Notice of Violation.

INEL generates mixed wastes that are radioactive and contain RCRA hazardous wastes banned from land disposal. The primary INEL compliance concerns for mixed wastes are the radioactively-contaminated wastes containing solvents and California list wastes as defined in 40 CFR 268.5. These mixed wastes are subject to the RCRA land disposal restrictions which ban the land disposal of certain listed hazardous wastes unless they meet specific treatment standards. Due to the nationwide shortage of treatment and disposal facilities for these types of waste, INEL is storing these mixed wastes until better treatment and disposal options are developed. Such storage violates the Land Disposal Restrictions provisions of RCRA which permits storage only for accumulation of sufficient quantities to facilitate proper treatment, recycle, or disposal. Therefore, the Idaho Operations Office has proposed to enter into a compliance agreement with DOE and the State of Idaho concerning the storage and continued generation of land disposal restriction waste until a treatment method is developed and WIPP or another suitable repository is open for disposal of mixed TRU waste. The land disposal restrictions also prohibit the storage of new restricted waste, including storage of new calcine, generated after May 1992, unless it is being accumulated to facilitate the proper treatment, disposal, or recovery, or there is an approved case-by-case extension. Because there are more than one million pounds of radiologically contaminated lead at INEL, serious efforts are being made to develop a

lead treatment process that can satisfy the land disposal restriction.

Schedules to develop such technologies are proposed in the draft Site Treatment Plan. When finalized, the Site Treatment Plan will satisfy DOE's obligation under the *Federal Facility Compliance Act* of 1992 to develop and submit a mixed waste treatment plan for INEL.

INEL is not presently in full compliance with the *Toxic Substances Control Act* (TSCA) due to the storage of some PCB-contaminated equipment and materials. The equipment and materials are also contaminated by various radioactive elements and treatment and disposal technology does not currently exist for these materials. DOE has an aggressive program to develop this technology but until it does, these materials must be safely stored in violation of the TSCA ban on the storage of such materials. DOE is presently negotiating a compliance agreement with the State of Idaho for the continued storage of radioactive PCB-contaminated wastes at INEL until a method for their treatment or disposal can be developed and permitted.

### A.1.2 Nevada Test Site

**Site Description.** NTS is located in Nye County, NV, and encompasses approximately 864,000 acres (1,350 square miles). It varies in width from 28 to 35 miles (east to west) and in length from 40 to 55 miles (north to south). To the north, east, and west, the rugged, mountainous, undeveloped, Federal-owned land masses of the Nellis Air Force Range provide a buffer zone, varying from 15 to 65 miles wide, between the test areas and public lands. The Bureau of Land Management manages the land which borders the southern and southwestern boundaries. United States Highway 95 and the town of Amargosa Valley are also to the south. The southeast corner of NTS is about 65 miles northwest of Las Vegas.

NTS is unique in that it is a large open area for which access is tightly controlled, with adequate infrastructure, to handle and run tests with hazardous or radioactive materials. Approximately 25 percent of NTS is currently undeveloped or provides buffer zones for on-going programs and projects. Facility expansions are possible within all areas and encroachment from land development is not a concern.

NTS is divided into numbered test areas to simplify the distribution, use, and control of resources (figure 4.3.1–1). The main entrance and the Desert Rock airstrip are at the southeast corner of the site (Area 22). Mercury base camp is adjacent in Area 23 and provides administrative operations and general support. Offices for DOE, DOD, Defense Nuclear Agency, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Sandia National Laboratories, New Mexico, and all of the supporting contractors of these organizations are located in this area. Dormitory, cafeteria, recreation, and transportation facilities are located here.

North of Mercury is Frenchman Flat (Area 5), an area historic for its atmospheric nuclear tests. Just north of Frenchman Flat is Area 6. The Control Point One facility which provides control over and execution of nuclear detonations at NTS is located here as is a new work-camp for construction and craft support. A shallow, usually dry, lake bed, Yucca Lake, is also in this area. Further north is the broad valley of Yucca Flat, site of much of the more recent nuclear testing (Areas 1, 2, 3, 4, 7, 9, and 10). At the northern edge of this flat at the base of Rainier Mesa, is the center of DOD/Defense Nuclear Agency activities (Area 12). The Area 12 Camp has logistic, service, and administration facilities, which, in busier times, supported the northern part of NTS but which has now been closed and consolidated with the Mercury and Area 6 camps. The Area 12 Camp provided ready access to the Defense Nuclear Agency tunnels mined into the face of Rainier Mesa. In the northwest section of NTS is Pahute Mesa. Its geology, combined with the greater distance from Las Vegas, allows its use for testing nuclear devices with larger yields (Areas 19 and 20).

Due to its large size, the perimeter of NTS is not fenced. However, roving security guards patrol the test site. Security and hazardous areas are fenced and some are protected with armed guards and electronic security measures. Capital assets at NTS include about 1,200 buildings with 8,000 units of installed equipment, approximately 300 miles of primary and secondary surfaced roads, and 400 miles of unsurfaced roads.

The NTS water system consists of 15 wells, pumps, booster pumps, and many sumps, reservoirs, chlorinator water softeners, and 100 miles of supply and

distribution lines. This water system has an average weekly production of 8.5 million gallons. Total well capacity is 5,752 gallons per minute (gpm). Twelve wells supply water for domestic use on NTS. Mercury basecamp is supplied by 3 wells: 2 in Area 5 and 1 near Desert Rock Airstrip.

Electrical power to NTS is supplied by Nevada Power Company and Valley Electric Association transmission lines. Both transmission lines are rated at 138 kilovolt (kV). The Nevada Power Company line is approximately 60 miles long and ties into the NTS transmission system near Mercury. The Valley Electric Association line is more than 100 miles long. It runs from the Amargosa Valley substation and ties into the NTS transmission system at Jackass Flats substation. This system (the Nevada Power Company/Valley Electric Association transmission lines) is capable of providing 45 megawatt electric (MWe) based on a single contingency failure. NTS has over 700 miles of overhead and underground transmission and distribution power lines. NTS also uses a small amount of fuel oil. Table 4.3.2.2–1 shows the annual usage of resources.

**Missions.** The missions of NTS include:

- Provide the capability to conduct underground nuclear weapons tests.
- Provide technology, facilities and expertise for non-DOE customers.
- Support site characterization of Yucca Mountain.
- Conduct environmental assessment and remediation.
- Provide the DOE response for radiological or malevolent nuclear emergencies.
- Dispose of low-level radioactive waste for DOE.
- Conduct offsite technical monitoring for nuclear treaty compliance.

**Facility Operations.** In December 1950, President Truman established the Nevada Proving Grounds (forerunner to NTS) as the Nation's on-continent nuclear weapons testing area. The first nuclear test at NTS occurred on January 27, 1951. At that time, the nuclear weapons program was administered by the Atomic Energy Commission Albuquerque Operations Office. Atomic Energy Commission employees were sent to the Nevada Proving Grounds for the duration of a test series and then returned to Albuquerque. As tests became more frequent during the 1960's, Atomic Energy Commission created the Las Vegas-based Nevada Operations Office, which officially opened on March 6, 1962, and has administered NTS operations since then. Approximately 40 percent of the total Nevada Operations Office budget for fiscal year 1992 was for defense programs activities.

NTS is operated by four major management and operations contractors. Contractor employment levels at the test site are dependent upon programmatic requirements and have varied greatly during the history of the site. During 1988, the peak year, roughly 11,000 contractor employees were assigned to Nevada Operations Office administered activities at NTS and miscellaneous other locations, including metropolitan Las Vegas and North Las Vegas, Nevada. From that peak employment level, and particularly in view of the test moratorium that was first implemented in the fall of 1992, contractor employment levels have decreased to approximately 8,700 as of June 1, 1994; and are predicted to decline further to approximately 8,000 as of September 30, 1994.

The majority of the facilities at NTS were constructed 25 to 30 years ago as temporary structures; less than ten percent have been constructed in the past 15 years. Many of the facilities are also currently inadequate in one or more of the structural, mechanical, or electrical categories. Although Mercury basecamp has close to 100 percent occupancy and some forward areas are at 80 percent occupancy levels, fiscal pressures are forcing the closure of the forward area facilities and consolidation at the Mercury basecamp. Consequently, most of the Mercury facilities are occupied with little reserve capacity.

Desert Rock Air Strip is located southwest of Mercury. The airstrip has in busier times provided scheduled air service by DOE aircraft between NTS and Lawrence Livermore National Laboratory, Los

Alamos National Laboratory, and Sandia National Laboratories, New Mexico, for access by researchers and testing personnel. Currently it is used only for high priority shipments.

Only one major new facility, the Device Assembly Facility, is currently under construction. However, modification of existing facilities on an as needed basis, is an ongoing activity. Drilled holes for groundwater monitoring are always in the process of being selected, designed, and developed. A waste management facility is being considered for handling TRU waste from DOE facilities; this is the only major non-defense program facility anticipated for NTS.

*Defense Program Activities.* Historically, most of the work carried out onsite has been related to defense program activities. Since it was established in December 1950, NTS has been the primary testing location for the Nation's nuclear explosives program. As of September 30, 1992, the United States had conducted 1,054 nuclear tests, 928 which were on the NTS and 828 of which were underground. A breakdown of the categories of the 928 nuclear tests conducted within the boundaries of the NTS from 1951, through 1992, is as follows:

- 100 atmospheric tests, 16 of which were safety tests that by design produced little or no nuclear yields.
- 10 cratering tests (i.e., shallow burial of a nuclear device).
- 9 tests in unstemmed holes to minimize, but not eliminate, the release of radioactivity to the atmosphere.
- 742 underground tests in drilled or mined shafts.
- 67 tunnel tests.

In typical defense program weapons development tests during the past several decades, a nuclear device was emplaced in a vertical drilled hole (86 to 190 inches in diameter) at depths of from 1,200 feet to 2,500 feet in the Yucca Flat basin or at Pahute Mesa. The nuclear device was assembled into the desired testing configuration and mated with a diagnostic equipment canister at NTS. Operational tests were performed repeatedly, both before and after the nuclear device was placed "down-hole," to ensure proper functioning of the telemetry. After the test package, up to 200 feet in length, was lowered to its proper depth, the vertical emplacement hole was backfilled with different materials in order to contain the resulting radioactive debris when the nuclear device was exploded.

A DOE Test Controller at the Area 6 Control Point made the final decision to "Go" or "Not to Go" for each test based upon the recommendations of his safety advisory panel. After detonation, sample recovery holes were bored into the test cavity to obtain samples of the nuclear debris for subsequent radiochemical analysis by the weapons design laboratory that furnished the nuclear device.

As has previously been noted, since the *U.S. Nuclear Testing Moratorium Act* went into effect in early October 1992, no nuclear tests have been conducted by the United States. On the day immediately following China's October 4, 1993, nuclear test, President Clinton issued a directive to DOE to continue to maintain indefinitely a state of readiness for possible resumption of U.S. testing.

The Device Assembly Facility is the only new major facility for defense program activities at NTS. This 100,000 $ft^2$ facility was authorized in 1984, and is under construction now. Physically, it is located just south of Control Point One. It will combine and centralize all the functions and facilities of the existing device assembly area. Once the Device Assembly Facility is operational, Lawrence Livermore National Laboratory and Los Alamos National Laboratory will be able to conduct multiple operations with high explosive(s) (HE) and nuclear devices simultaneously. All aspects of the operations will be handled in this one facility due to its multiple processing areas which include; assembly cells, assembly bays, high bays, radiographic facilities, special nuclear materials laboratories, HE staging, special nuclear materials staging, shipping and receiving areas, and associated administrative and support areas. In addition, the facility will provide for increased overall security and permit easier entrance/exit for the workers during hazardous operations. There will be no manufacturing or machining of special nuclear materials at this facility.

The Nevada Operations Office has been delegated the lead Federal role in maintaining the capability to respond to certain kinds of national emergencies. It will provide the leadership when a Federal Radiological Monitoring and Assessment Center is established. Additionally, a team of highly trained DOE and contractor radiological specialists known as the Nuclear Emergency Search Team trains, tests equipment for search and detection, and stores equipment for rapid deployment under the auspices of the Nevada Operations Office. It can be mobilized in case of accidents involving radioactive materials or a terrorist threat involving nuclear weapons.

*Other Department of Energy Activities.* Although the principal activity at NTS is the underground testing of nuclear devices, DOE is also involved in a number of other activities. These activities include liquified gaseous fuels spill testing, radioactive and mixed waste disposal, and the Yucca Mountain characterization programs. NTS has also been designated a DOE National Environmental Research Park.

The Liquified Gaseous Fuels Spill Test Facility in Area 5 was completed in 1986. It was operated on a fee basis for commercial users as a basic research tool for studying the dynamics of accidental releases of hazardous materials and to evaluate the effectiveness of various foams and fire retardants in accidents involving chemicals and hazardous materials. Test facility personnel discharge a measured volume of hazardous test fluid at a controlled rate onto a surface specially prepared to meet the test requirements and record close-in and downwind meteorological data and gaseous concentration levels.

NTS also operates radioactive waste disposal facilities. The Radioactive Waste Management Site, located in Area 5, accepts LLW materials which were generated in the Nation's defense programs activities. This 92-acre facility consists of trenches and pits for burial of short-lived LLW, and aboveground storage of TRU waste awaiting transfer to the Waste Isolation Pilot Plant (WIPP). Also located at the Area 5 Radioactive Waste Management Site is the Greater Confinement Disposal Facility which consists of a 10 foot diameter lined shaft 120 feet deep. This facility is used for disposal of waste not suited for shallow land burial because of potential for migration into biopathways. Nonradioactive hazardous wastes are also accumulated at the Area 5 Radioactive Waste Management Site awaiting shipment to offsite disposal facilities. In Area 3, the Bulk Waste Management Site uses surface subsidence craters (that were formed by underground nuclear tests) for the emplacement and burial of LLW in bulk form (such as debris collected from atmospheric nuclear test locations).

The Yucca Mountain Site is located at the edge of NTS. It is being considered by DOE for the disposal of spent power-reactor fuel and vitrified high-level waste (HLW), the latter resulting principally from defense program activities. The Yucca Mountain Site Characterization Project staff reports directly to DOE's Office of Civilian Radioactive Waste Management. However, because it has elements based on NTS, the Nevada Operations Office provides some administrative and operational support services to the project. Current designs for the Yucca Mountain Project reflect an electrical demand of 10 MWe; this design has been downsized from earlier estimates of 30 MWe.

Recently, NTS has been designated as a DOE National Environmental Research Park with a purpose of consolidating previous ecological reports, filling in a significant gap in the existing DOE research park network, and providing a unique opportunity for research in the arid desert environment. This not only enables NTS scientists to link into the existing ParkNet computerized data system, but also makes the extensive accumulation of environmental research collected over the history of NTS available to students and scientists throughout the world. NTS's location in the transition zone between the Southern and Northern Basin and Range Ecological Regions, and its inclusion of vast undisturbed areas of mountain ridges, closed basins and diverse ecological communities makes it particularly valuable.

From 1959 through 1973, NTS supported a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests in Area 25 at the Nuclear Research and Development Area. Another series of tests with a nuclear ramjet engine was conducted in Area 26.

*Non-Department of Energy Activities.* The most significant NTS activity involving non-DOE organizations has been the Defense Nuclear Agency's nuclear testing facility. Congressional legislation (the

*Hatfield Amendment*), however, limited nuclear testing to those tests that support the safety and reliability of the U.S. nuclear stockpile. This may preclude further Defense Nuclear Agency nuclear tests which are done to support research into nuclear weapons effects.

Defense Nuclear Agency nuclear tests occurred in horizontal tunnels mined beneath Rainier Mesa. The nuclear devices for these tests were designed, built, funded, controlled, and executed by DP. Defense Nuclear Agency's nuclear testing provided the data base and design information for both nuclear effects and survivability. Nuclear weapons effects were studied for all U.S. tactical and strategic weapons systems that were required to operate in a nuclear warfare environment. These tests played a major role in maintaining high confidence in the nuclear stockpile and nuclear capable weapon systems. The weapons effects tests were conducted to study a number of nuclear effects including X-ray, gamma-ray, neutron, stress (thermal, electrical, and mechanical), electromagnetic pulse, airblast, ground and water shock propagation, and temperature. These tests assessed both weapons effects and the survivability of military systems in a nuclear environment.

Area 85 has been used for a variety of purposes, including U.S. Army ballistic research using depleted uranium and transporter testing for the proposed mobile MX missile. Various military exercises and training activities are also conducted in and around Area 25.

The Desert Research Institute, EPA, the University of Utah, and the Nevada Operations Office operate the Community Radiation Monitoring Program. This program provides the community surrounding NTS with an increased understanding of it's activities and the natural radiation environment.

Other activities have been, and will likely continue to be, carried out for other Federal departments and agencies. Representatives from the EPA, U.S. Geological Survey (USGS), and National Oceanic and Atmospheric Administration are onsite to assist and monitor conditions.

**Environmental Regulatory Setting.** Underground and aboveground testing at NTS has resulted in contamination of surface and subsurface soils and water, and the release of some radioactive isotopes and byproducts, such as metals, into the environment. A Memorandum of Understanding between DOE and the State of Nevada covers radiological releases on NTS and the required notifications. DOE has signed a Programmatic Agreement with the State of Nevada to cover archaeological and historical preservation activities. All future activities at NTS must comply with both the Memorandum of Understanding on radiological releases and the Programmatic Agreement.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at NTS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. This section discusses the more important agreements and other regulatory issues that must be considered before making a decision that would affect NTS.

An Agreement in Principle with the State of Nevada was signed in October 1990, and provides DOE funding to Nevada for oversight of ES&H activities, including the environmental restoration activities at NTS. The Agreement in Principle also provides for understanding between, and commitment of, the parties regarding DOE's provision to the state for technical and financial support in return for environmental oversight and monitoring. NTS environmental permits include 43 different State of Nevada air quality operating permits involving emissions from construction, operation of facilities, boilers, storage tanks, and open burning. Five permits for onsite drinking water systems, eight permits for hauling septage, and one consolidated permit for four sewage discharges to onsite lagoons or septic tank fields also have been issued by the State of Nevada. The RCRA Part B permit application for hazardous waste was approved by the state in 1990 as number NV3890090001.

*Air.* Air pollution sources at NTS include aggregate production, stemming activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage

facilities. The air pollutant of major concern at NTS is particulate matter which includes primarily fine sands emitted during stemming and tunneling operations, and carbon particles emitted during fuel combustion. NTS air quality operating permits contain clauses limiting the emission of particulates. Radionuclide emissions are not a problem as no significant emissions of radioactive material from venting, ventilation, or seeps have reached the uncontrolled areas surrounding NTS since 1980.

Many of these air quality operating permits require annual reports on operating hours, production summaries, occurrences of open burning, and other similar information. For example, the Nevada Air Quality Officer must be notified of each burn no later than five days following the burn. During 1990, three open burns of explosives-contaminated debris in Area 27 were reported for this permit. Also, the Nevada Air Quality Officer must be notified by telephone at least two working days in advance of each training exercise for Class A flammables, and a written summary of each exercise must be submitted within 15 days following the exercise. During 1990, seven burns were conducted for radiological emergency response training and ten training burns were conducted by onsite fire protection services.

*Water.* Effluents at NTS are primarily the result of equipment cleaning and sanitary wastes. Discharges also result from groundwater seeping into the tunnels in Rainier Mesa. Tunnels have been sealed with the exception of P-Tunnel which drains to a holding tank. There are no NPDES permits for Nevada Operations Office facilities because there are no wastewater discharges to onsite or offsite surface waters. Water monitoring at NTS was limited to sampling wastewater effluent to lagoons and ponds under a series of State of Nevada permits.

*Land.* NTS manages two radioactive waste management sites and one hazardous waste accumulation site. As a result of its vast area, prior aboveground testing activities, and remote location, NTS serves as a disposal site for LLW generated by onsite and offsite DOE nuclear weapons program activities and facilities. NTS also serves as an interim storage site for TRU and mixed TRU wastes from its own activities and from Lawrence Livermore National Laboratory activities, prior to eventual shipment to WIPP for final disposal. Extensive environmental surveillance is conducted on NTS to monitor the radioactive waste management program sites. NTS previously served as a disposal site for DOE-nuclear-weapons-program-generated mixed wastes received under an interim status provision granted by the State of Nevada. In May 1990, mixed waste disposal operations were discontinued due to EPA issuance of the RCRA land disposal restrictions for the Third Thirds wastes. Active mixed waste disposal operations at the NTS will not commence until issuance of a State of Nevada RCRA Part B permit.

The State of Nevada has been delegated authorization to enforce RCRA by EPA. The Nevada Division of Environmental Protection provides RCRA overview of NTS. The RCRA Part A permit application for NTS was updated in 1990, to include additional onsite disposal units which will be subject to RCRA closures in the future. The RCRA Part B permit application, approved in 1990, for disposal of hazardous waste and storage of mixed waste, is being updated to include all active and proposed expansion of mixed waste storage and disposal units on NTS.

The Hazardous Waste Accumulation Site consists of an impervious concrete pad with 6-inch curbs to contain spillage and runoff and a roof to protect the wastes from rain. This site is used to collect nonradioactive hazardous wastes from satellite accumulation areas prior to shipping offsite to a RCRA-permitted commercial hazardous waste disposal facility. Hazardous waste is removed from NTS in less than 90 days from receipt at the Hazardous Waste Accumulation Site. Final permitting of this site should resolve issues concerning satellite accumulation points for RCRA-generated wastes.

On August 10, 1992, the state notified the Nevada Operations Office of its opinion that the uranium oxide material called Cotter Concentrate stored at NTS is probably a waste that has not yet been declared a waste. The state has requested chemical and physical data regarding the material and, if known to contain RCRA constituents or is uncharacterized, justification should be provided for continuing to classify the material as strategic material, rather than as a waste. On January 8, 1993, DOE declared that this material has no further programmatic use and that it be transferred to waste management for final disposition.

The Radioactive Waste Management Site at Area 5 is a 732-acre remote radioactive waste storage and disposal facility. Area 5 contains LLW disposal units consisting of pits and shallow trenches. It also provides the Greater Confinement Disposal Unit which consists of a 10-foot diameter shaft 120 feet deep used for experimental disposal of wastes not suited for shallow land burial because of high specific activity or a potential for migration into biopathways. Area 5 also serves as temporary storage for TRU and mixed TRU wastes on a curbed asphalt pad. Approximately 785 cubic yards ($yd^3$) of TRU wastes are stored in 55-gallon drums on pallets and in various assorted steel boxes pending shipment to WIPP.

DOE and the State of Nevada signed a Settlement Agreement on June 23, 1992, regarding alleged violations of storage of mixed TRU waste at NTS. Currently, the Nevada Operations Office plans to retain the existing inventory of mixed TRU waste subject to the permitting of the storage facility. This agreement resolves an alleged violation issued on November 1, 1990, by Nevada Division of Environmental Protection as a result of an August 1990, inspection alleging storage of mixed waste without a permit and lack of proper waste characterization. The agreement also resolves a finding of alleged violation issued on June 24, 1991, alleging an increase in the design capacity of the TRU storage pad without prior state approval. The NTS Waste Analysis Plan, submitted in April 1991, as amended by Nevada Division of Environmental Protection, outlines the characterization procedures to be used as a result of the agreement.

As a result of this Settlement Agreement DOE will:

- Limit mixed TRU waste storage at Area 5 to the current inventory of approximately 743 $yd^3$ (150,000 gallons).
- Obtain a Nevada hazardous waste permit before additional mixed TRU wastes are to be stored at NTS.
- Document why the current inventory of mixed TRU waste cannot be removed until after WIPP becomes operational.
- Report annually on its progress in certifying that the TRU waste stored at NTS meets the WIPP Waste Acceptance Criteria.
- Operate the Area 5 TRU waste storage pad until the waste is removed in accordance with 40 CFR 265, Subpart I.
- Obtain approval for, and construct, a cover for the waste.

A Consent Decree between the State of Nevada and Reynolds Electrical & Engineering Company, Inc., was filed on August 24, 1992, regarding alleged inadequate sampling of pondered received from the Rocky Flats Plant (now known as the Rocky Flats Environmental Technology Site) to be disposed at NTS in the Radioactive Waste Management Site. The resolution was a monetary payment to Nevada and the submission of a schedule for development of a sampling plan for the adequate characterization of the remaining pondered to be disposed at NTS.

The other Radioactive Waste Management Site is the Area 3 Bulk Waste Management Facility which accepts bulk LLW that cannot be packaged for disposal at the Area 5 Radioactive Waste Management Site. Much of the waste material buried there is contaminated soil and metal remaining onsite from the atmospheric testing of nuclear weapons at NTS. The materials are deposited in two waste management units, each consisting of two subsidence craters with the area between the craters excavated to form a large oval disposal unit.

In 1987, a DOE task force determined that underground nuclear device testing areas are subject to the provisions of CERCLA. Under CERCLA all releases of hazardous or extremely hazardous substances that exceed reportable quantities must be reported to the National Response Center. Preliminary Assessment/Site Investigation reports required by CERCLA were prepared for NTS and provided to the EPA in 1988. The contaminants of concern at NTS are the results of historic aboveground and underground testing, the disposal of incidental wastes generated in support of the testing operations, and nuclear rocket experiments. Prior to 1963, soils contaminated during the atmospheric nuclear testing were consolidated and disposed of in fill areas. Soils and equipment contaminated with radionuclides as a result of quillback or tunnel operations were also

disposed of in the drill areas at NTS. The types of possible contaminants found on the surface of NTS include: radionuclides; organic compounds; metals such as beryllium, lead, and hydrocarbons; and residues from plastics, epoxy, and drilling muds used during test boring drilling and instrumentation. Soils contaminated by plutonium are also a concern. EPA will use the revised Hazard Ranking System to determine if any NTS sites are to be included on the NPL. If NTS is placed on the NPL, then DOE anticipates entering into an interagency agreement with the State of Nevada and EPA.

### A.1.3 Oak Ridge Reservation

**Site Description.** ORR consists of approximately 34,700 acres of Federal-owned lands located directly to the west and south, but within the incorporated city limits of Oak Ridge, TN. The city of Oak Ridge and ORR are within the region known as the Great Valley of the Tennessee River, which lies between the Comburant and Southern Appalachian mountain ranges. About 10 miles to the northwest, the Comburant mountains rise to an elevation of 3,000 feet or more while the Great Smoky Mountains National Park reaches to heights over 6,600 feet some 70 miles to the southeast. The largest city in the area, Knoxville, is located approximately 30 miles to the southeast. Land use in the five-county area surrounding ORR varies from the heavily populated and highly developed urban areas around Knoxville, to the sparsely populated areas immediately surrounding ORR. The largest single land use for each of the five counties is forestry; the second most common use is agriculture.

DOE has three primary complexes within ORR. These are the Y-12 Plant (Y-12), the K-25 Site (formerly the Oak Ridge Gaseous Diffusion Plant), and the Oak Ridge National Laboratory. Originally built in the early 1940's for large-scale production of fissionable material for the world's first nuclear weapon, they continue to be used today as research, development, and manufacturing facilities (figure 4.4.1–1 and table 4.4.2.2–1).

Y-12 is situated on 811 acres in the eastern end of ORR in the location known as Bear Creek Valley. Primary missions of Y-12 include dismantling nuclear weapon components returned from the national arsenal, maintaining nuclear production capability and stockpile support, and providing storage for special nuclear materials. Y-12 also supports other federal agencies through a Work for Others program. In addition, a technology transfer program has been established to support the U.S. industrial base by applying Y-12 expertise to a wide range of manufacturing problems. All of the uranium parts used in building U.S. nuclear weapons were fabricated at Y-12. The plant itself consists of 494 buildings containing more than 7 million $ft^2$ of floor space.

Although the primary mission of K-25 has been to provide enriched uranium for U.S. nuclear weapons and, later, an industrial toll enrichment service by which uranium is enriched for use in power reactors around the world, the gaseous diffusion process at K-25 designed for that function was placed in permanent shutdown in 1987, because of a lack of weapons or commercial requirements. Today, K-25 serves as operations center for Environmental Restoration and Waste Management Programs. The Site is also the home of DOE's Center for Environmental Technology and Center for Waste Management.

Oak Ridge National Laboratory programs focus on basic and applied research, technology development, and technology that has been designated important to DOE and the Nation. It also performs work for non-DOE sponsors when such activities complement DOE missions and address significant national or international issues. In addition, Oak Ridge National Laboratory supplies radioactive and stable isotopes that are not available from the private sector.

The 604 buildings on ORR outside Y-12 contain more than 17 million $ft^2$ of floor space. Most of these buildings and structures are located within K-25 or Oak Ridge National Laboratory; however, several buildings and structures owned or leased by DOE are outside ORR. The onsite buildings and structures outside the major plant sites consist of the Scarboro Facility, the Central Training Facility, the Transportation Safeguards Division Maintenance Facility, and some ancillary structures. Most physical facilities used by the various plant protection and security groups are within the primary plant's fenced area; however, the target ranges are outside the fence but within the buffer zones of the main plant areas. Small-arms ranges are located on the east end of Y-12

and north of the west end of Oak Ridge National Laboratory.

The Scarboro Facility, located within ORR and south of Y-12, houses the Oak Ridge Institute for Science and Education's Medical and Health Sciences Division's Large Animal Research Program. The Central Training Facility is shared by the site security force; DOE's Transportation Safeguards Division; and other contractor and agency security personnel. This facility also consists of a small office building, an indoor firing range, classroom and storage trailers, onsite parking, fitness facilities and numerous outdoor firing ranges. The site, located less than a mile southeast of K-25, currently consists of about 140 acres including a buffer area. The Transportation Safeguards Maintenance Facility is the former Stone & Webster warehouse, located about one mile east of K-25.

The offsite buildings and structures consist of the Oak Ridge Operations Office, the DOE Office of Scientific and Technical Information, the Oak Ridge Institute for Science and Education facilities, the American Museum of Science and Energy, the prime contractor's "Townsite" facilities, the National Oceanic and Atmospheric Administration's Atmospheric Turbulence and Diffusion Laboratory, and others. With the exception of the Federal Office Building and space leased from the private sector, all buildings and structures used for DOE functions are situated on DOE-owned land.

**Missions.** The missions of ORR include:

- Maintain capability to fabricate uranium and lithium components and parts for nuclear weapons.
- Store uranium and lithium materials and parts.
- Dismantle nuclear weapons components returned from the stockpile.
- Process uranium, some of which is subject to International Atomic Energy Agency storage.
- Provide support to design agencies as requested.
- Perform waste management and D&D activities at Oak Ridge National Laboratory, Y-12, and K-25.
- Operate the Oak Ridge National Laboratory to perform basic research and development in energy, health, and environment and to produce radioactive and stable isotopes not available elsewhere.
- Sponsor Oak Ridge Institute for Science and Education programs in the areas of health, environment, and energy.
- Perform projects to support other Federal programs.
- Maintain programs to transfer unique technologies developed at Oak Ridge to private industry.
- Perform meteorological and atmospheric diffusion research.

**Facility Operations.** The complexes at ORR are managed by a management and operations contractor, under a contract administered by the Oak Ridge Operations Office. Current missions and functions can be grouped into the following categories: defense program activities; DOE Office of the Assistant Secretary for Environmental Management (EM) activities; other DOE Activities; and non-DOE activities.

*Defense Program Activities.* All defense program activities at ORR are conducted within Y-12. The plant site consists of approximately 811 acres, 630 of which are enclosed by perimeter security fencing and contains 494 buildings or other structures totaling approximately 7 million $ft^2$. The site supports Nuclear Weapons Production and Surveillance and Nuclear Materials Production mission assignments housed in approximately 425 of the 494 buildings and utilizing some 5.4 million $ft^2$ of floor space.

Y-12 missions include dismantling nuclear weapon components returned from the national arsenal, maintaining nuclear production capability and stockpile support, and storing special nuclear materials. Y-12 also stores depleted uranium.

Another important mission of Y-12 is the processing of uranium. Uranium materials are also recovered from the fabrication process and the disassembly of retired weapons. In addition to its functions related to uranium materials, Y-12 performs precision machining and assembles components, provides fabrication support to DOE's weapon design laboratories, and produces components for design evaluation for these customers and most of the test devices used at NTS.

*Other Department of Energy Activities.* Other DOE activities conducted at ORR include missions and programs of K-25, Oak Ridge National Laboratory, Y-12 non-defense programs, the Oak Ridge National Environmental Research Park, the Oak Ridge Institute for Science and Education, and the American Museum of Science and Energy. K-25 contains approximately 1,700 acres and is located six miles northwest of Y-12. The site consists of 250 buildings with approximately 12.2 million $ft^2$ of floor space. The original mission of K-25 was to separate uranium-235 for use in atomic weapons. In December 1987, DOE permanently shut down the gaseous diffusion processes and K-25 was placed on the list of facilities slated for decontamination and decommissioning. Today, K-25 serves as the operations center for Environmental Restoration and Waste Management Programs. It is also the home of DOE's Center for Environmental Technology and Center for Waste Management. Missions and activities include technology development, technology transfer, engineering technology, uranium enrichment support, and the central functions of business management, engineering, computing and telecommunications.

The Oak Ridge National Laboratory complex consists of approximately 2,900 acres located 4 miles southwest of Y-12. The site has approximately 240 buildings containing 2.7 million $ft^2$.

Activities at Oak Ridge National Laboratory include basic and applied research, technology development, and other technology important to DOE and the Nation. Oak Ridge National Laboratory also performs research and development for non-DOE sponsors when such activities complement DOE missions and address significant national or international issues. Missions and activities include energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

Oak Ridge National Laboratory also designs and provides research facilities for the scientific and technical community and supplies radioactive and stable isotopes that are not available from the private sector. Major portions of ORR are used by Oak Ridge National Laboratory in their aquatic habitat, flora, fauna, and other environmental sciences research programs.

In addition to defense program activities described above, Y-12 provides processing of radioactive source materials and support for other government agencies. Some 47 buildings containing 1.5 million $ft^2$ located on Y-12 grounds are utilized by Oak Ridge National Laboratory in support of non-defense program missions. Oak Ridge National Laboratory employs some 450 people at Y-12. Also located on the Y-12 site are approximately 20 buildings containing 300,000 $ft^2$ which house the DOE construction manager, the water plant maintenance contractor for ORR, and several organizations of the Oak Ridge Operations Office. Employment in these activities include 175 in DOE and 550 in construction manager organizations.

The Oak Ridge National Environmental Research Park, established in 1980, consists of 13,590 acres on the ORR. As one of seven DOE research parks, its purpose is to provide protected land areas for research and education in the environmental sciences and to demonstrate that energy technology development is compatible with a quality environment. There are 53 active Environmental Sciences Research Sites consisting of 3,562 acres on ORR. In addition, there are 15 inactive sites on a total of some 323 acres.

Oak Ridge Institute for Science and Education's primary missions are to provide educational and research programs in the areas of health, environment, and energy for DOE, other federal agencies, and private industry. The American Museum of Science and Energy is located at a site contiguous to the Oak Ridge Institute for Science and Education campus. The museum contains historical displays and exhibits about energy in its various forms as well

as topical matter on the growth of the nuclear power industry.

*Non-Department of Energy Activities.* Non-DOE activities pursued at ORR include missions and programs of the National Oceanic and Atmospheric Administration which conducts meteorological and atmospheric diffusion research that is supported by both itself and DOE. This work is done at the Atmospheric Turbulence and Diffusion Laboratory and field sites on ORR. The laboratory also provides services to DOE contractors and operates the Weather Instrument Telemetering Monitoring System for DOE.

**Environmental Regulatory Setting.** ORR consists of three separate sites in and around the city of Oak Ridge; however, all Federal and state environmental agreements deal with ORR as a single entity. The State of Tennessee, which has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste, entered into a five-year Monitoring and Oversight Agreement with DOE on May 13, 1991, to assure Tennessee citizens that their health, safety, and environment are being protected during ORR facility operations. The Tennessee Department of Environment and Conservation is the lead state agency for implementation of this agreement in which DOE provides financial support to allow Tennessee to carry out its commitment under the oversight agreement and the Federal Facility Agreement regarding cleanup activities. In addition, ORR performs its own environmental monitoring of effluents and surveillance of the environmental media to characterize and quantify contaminants, assess radiation exposures of members of the public, demonstrate compliance with applicable standards and permit requirements, and assess the effects, if any, on the local environment. The Oversight Agreement also ensures that DOE complies with all applicable laws, regulations, and orders.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. This section discusses the more important agreements and other regulatory issues that must be considered before making a tritium supply decision that would affect ORR.

On December 21, 1989, EPA placed ORR on the NPL as a "Superfund Site" pursuant to the provisions of CERCLA. This determination was based on the contamination present due to past practices.

*Air.* Regulation of radionuclide air emissions at ORR is governed by the Federal Facility Compliance Agreement for CAA (Rad-NESHAP) signed May 26, 1992, and the Radionuclide NESHAP Compliance Plan for ORR, dated April 17, 1991. The *National Emissions Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H) requires sampling and reporting to demonstrate compliance with the 10 mrem per year effective dose equivalent standard. Continuous emission sampling is required for any emission point with the potential to cause a dose exceeding 0.1 mrem per year. During 1992, 65 of 81 continuously monitored stacks were judged to have the potential to emit radioactive effluents that contribute greater than 0.1 mrem per year effective dose equivalent to an offsite individual. On March 26, 1993, EPA Region IV certified that DOE had completed all of the actions required by the ORR Rad-NESHAP Federal Facility Compliance Agreement and is considered to be in compliance with the Rad-NESHAP regulations. The annual offsite dose to the most-exposed member of the public for ORR was 1.4 mrem in 1992, well below the 40 CFR 61 standard of 10 mrem per year (OR DOE 1993a:xxxviii).

*Water.* A DOE water treatment facility supplies potable water to the city of Oak Ridge and other ORR facilities. The water is treated, chlorinated, and fluoridated before distribution and meets health standards. Activities are underway to reduce discharges of priority pollutants, high temperature water, and toxic agents such as chlorine to the East Fork Poplar Creek. Two dechlorination systems were installed in late 1992, at key outfalls on East Fork Poplar Creek to help control discharges of chlorine from non-contact cooling water systems and to help to eliminate chronic fish kills in the upper reaches of the creek. Additional efforts relating to reducing non-point-source pollutants to surface streams and

cleaning up mercury pollution in the East Fork Poplar Creek are being planned.

NPDES permits are required for each ORR facility. Y-12 is operating at the standards of the permit which expired in May 1990, and submitted a renewal in November 1989, with an addendum submitted in January 1993. Oak Ridge National Laboratory is operating at the standards of the permit which expired in April 1991, and submitted a renewal on October 28, 1990. Oak Ridge National Laboratory submitted a request to the state for modification of its NPDES permit based on evidence that past exceedance of total suspended solids, oil, and grease limits in the past have not impacted watershed water quality. A renewed NPDES permit was issued to K-25 on October 1, 1992, that will eliminate many of the permit exceedances which occurred repeatedly under the expired permit, but were not related to discharges from K-25. The new permit requires monitoring of storm drain discharges into settling ponds and streams, not at the outlets of these streams and ponds as did the expired permit.

Personnel at Y-12 operate a sanitary collection sewer system. Sanitary wastewater is discharged to the city of Oak Ridge under an industrial pretreatment permit. A new monitoring station was completed January 16, 1993, which allows for more accurate monitoring of the sanitary sewage discharges by Y-12. In addition to the sanitary sewer system, ORR submitted individual stormwater permit applications in October 1992, for all three sites, as required by the *Clean Water Act* (CWA) and Tennessee regulations. ORR had been performing extensive sampling since June 1991, in preparation for these applications.

On January 17, 1992, Friends of the Earth, a nonprofit corporation, filed a lawsuit against DOE in Federal District Court in Knoxville, TN. The lawsuit alleges that DOE is violating the NPDES permits because discharges of certain quantities of various pollutants into tributaries of the Clinch River have exceeded the allowable discharge limits of the NPDES permits. Friends of the Earth filed a motion for summary judgement in October 1992, and DOE filed a cross-motion for denial of summary judgement in January 1993.

*Land.* To satisfy the requirement under Section 104 of CERCLA for an interagency agreement, DOE, EPA Region IV, and Tennessee completed a Federal Facility Agreement effective January 1, 1992. The purposes of the Federal Facility Agreement are to: establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at ORR in accordance with CERCLA, RCRA, NEPA, appropriate guidance and policy, and Tennessee state law; coordinate future assessments and most of the remedial action activities planned at ORR pertaining to environmental restoration activities under CERCLA with state laws and existing corrective actions required under the RCRA permit issued to DOE for ORR effective on October 25, 1986; minimize the duplication of investigations, analytical work, and documentation; ensure the quality of data management; expedite response actions with a minimum of delay; and achieve a comprehensive remediation of the site. The Agreement also addresses technical standards for new and existing liquid LLW storage tank systems; conduct of remedial investigation/feasibility studies and remedial design/remedial actions in accordance with timetables for sites listed in Appendix E of the Federal Facility Agreement; setting of annual priorities; and provision of responsive guidance by regulators when requested.

ORR facilities are being operated with a combination of RCRA Part B permits and interim status regulations. The RCRA Part B permit applications have been submitted for all of the active storage and treatment units listed on the Part A permit. Some are approved and other Part B applications are still awaiting action by the State of Tennessee. ORR facilities generate hazardous wastes, and personnel operate hazardous waste treatment and storage facilities. However, there are no units actively used for the disposal of hazardous wastes. Closure actions are complete for several previously used hazardous waste disposal units.

DOE declared a moratorium in May 1991, on the shipment of hazardous waste to non-DOE sites to prevent waste, potentially contaminated with radioactive material, from being shipped to a facility which is not licensed to handle radioactive material. Current DOE policy on No Rad Added, which resulted from the moratorium, effectively requires all RCRA hazardous waste generated at ORR (and other DOE facilities) to be managed as mixed waste until ORR Waste Management provides sufficient

evidence to convince an independent review board for each offsite shipment that selected waste streams are free of radioactivity. The No Rad Added policy, therefore, restricts the ability of ORR to ship offsite RCRA hazardous waste generated at ORR facilities. (OR DOE 1993a:xxxix).

DOE and EPA signed a Federal Facility Compliance Agreement effective June 12, 1992, covering concerns related to the RCRA land disposal restrictions. This Agreement recognizes that DOE is currently storing and will continue to generate and store hazardous wastes, including mixed wastes which contain a hazardous waste component, subject to land disposal restrictions: solvent waste, California list waste, and Third Thirds waste. The agreement requires DOE to submit for EPA review a plan for a waste minimization program at ORR that provides for segregation of hazardous wastes from mixed wastes, substitution of nonhazardous solvents for hazardous solvents where technically practicable, and the minimization of the generation of hazardous waste throughout ORR. In addition to agreeing to implement the waste minimization program, DOE agreed to submit the following additional plans to EPA for review and approval: storage of the land disposal prohibited wastes identified in the Federal Facility Compliance Agreement; the treatment method, facility, and schedule for treating the land disposal prohibited wastes with identified existing treatment; the strategy for conducting treatability studies, technology development, and prioritization of treatment method options for land disposal prohibited wastes without identified existing treatment; and the treatment method, facility and a schedule for the completion of such treatment for wastes without identified existing treatment. This last plan is required not later than March 1995. The RCRA-Land Disposal Restrictions Federal Facility Compliance Agreement and the information provided in the required plans would form the basis for the site-specific mixed waste treatment plan required by the *Federal Facility Compliance Act* of 1992, for DOE facilities storing mixed wastes.

The ORR underground storage tank program regulates approximately 80 tanks and includes some that are deferred or exempt from external regulation. The tanks store petroleum and hazardous substances. ORR is ahead of its schedule for upgrading and/or replacing the underground storage tanks to implement leak detection, spill and overflow protection, and corrosion protection on all regulated tanks by 1998.

ORR facilities have PCBs from past practices and continue to generate PCB-contaminated wastes. These wastes are either shipped to a commercial disposal site, or if contaminated with uranium, stored until the TSCA Incinerator at K-25, which began operations in 1990, can process the waste. Some PCB-contaminated wastes have been stored in excess of one year due to: specific constituents in the waste that render it unacceptable at the TSCA incinerator; the burn priority at the incinerator; or the use of other treatment methods.

TSCA requires PCB-contaminated wastes to be disposed of within one year of its initial placement in storage. Due to its radioactive nature, treatment and disposal technology does not exist for most of these wastes. DOE has an aggressive program to develop this technology, but until it is available, these PCB-contaminated wastes must be safely stored, although not in compliance with TSCA. On June 11, 1992, DOE formally requested negotiation of a Federal Facility Compliance Agreement with EPA which would allow development of an ORR treatment and disposal schedule for radioactive PCB-contaminated waste and storage or disposal per the Agreement.

### A.1.4 Pantex Plant

**Site Description.** Pantex is located in the panhandle of Texas in Carson County. It is about 17 miles northeast of downtown Amarillo (population 157,600) and 40 miles southwest of Pampa (population 19,900). The plant is located on a 16,000-acre portion of the former Pantex Army Ordnance Plant. Pantex was constructed in the first half of the 1940's by the U.S. Army for the production of conventional ordnance. At the end of World War II, the plant was deactivated and the property eventually reverted to the War Assets Administration. In 1949, the entire installation was sold to Texas Technological College (now Texas Technological University) for one dollar. The land was to be used for experimental farming, but was subject to recall under the National Security Clause. Following an extensive survey of World War II ordnance plants, Pantex was chosen in 1951, by the Atomic Energy Commission for expansion of its nuclear weapons assembly facilities. The Army

Ordnance Corps reclaimed the site for the Atomic Energy Commission and contracted a civilian contractor to rehabilitate it.

Pantex consists of 425 buildings containing approximately 2,500,000 $ft^2$ of floor space. Within the 16,000 acres, approximately 2,000 acres are dedicated to active facility operations. Approximately 8,080 acres are devoted to storage, disposal, and miscellaneous activities in support of plant operations. The remainder of the plant site, or about 5,800 acres, is leased from Texas Tech University to provide a Government-controlled safety and security zone on the south side of the facility. The buffer zones are used by Texas Tech University for agricultural research with some acreage leased for private farming. An additional 1,080 acres northeast of the facility provide supplemental water rights and include a lake formerly used for the disposal of treated sewage effluent. Plant acreage also contains some 47 miles of paved roads, 17 miles of railroad tracks, 67 miles of fence, and 4 playa lakes. All the land within a 3-mile radius of the plant site is used for agricultural purposes, either farming or grazing. Approximately 2,000 people live within eight kilometers (five miles) of the outside boundary of Pantex. A significant population concentration occurs southwest of the Pantex facility near the Amarillo International Airport and includes the Texas State Technical Institute and the Highland Park Village. Highland Park Village consists of 500 single- and multiple-family housing units (duplexes) with an occupancy rate averaging about 90 percent. Approximately 100 students are housed in a Texas State Technical Institute student dormitory.

The main mission of Pantex is the manufacture of HE components and the assembly and disassembly of nuclear weapons. Activities in support of the mission are conducted in portions of the facility referred to as zones. The major zones are shown in figure 4.5.1–1 and Pantex baseline characteristics are summarized in table 4.6.2.2–1.

Almost 3,000 personnel support Pantex's mission. This includes area office personnel from DOE, Sandia National Laboratories, New Mexico, employees actively working in quality evaluation, the Courier Section personnel tasked with weapon transportation, and contractor employees that operate the plant. Plant operation includes Direct and Support Manufacturing Operations, Management and Administrative Services, Protective Services, and Maintenance and Utilities. During normal operations, some 600 people are assigned primarily to the Zone 12 South Material Access Area. Approximately half of these individuals routinely handle the radioactive components that are used in weapon production. The Material Access Area is a highly restricted area where special nuclear materials are staged and assembled.

**Missions.** Pantex missions include:

- Manufacture HE components for use in nuclear weapons.
- Assemble new nuclear weapons.
- Retrofit, maintain, and repair nuclear weapons in the stockpile.
- Provide quality assurance evaluations of nuclear weapon systems.
- Assemble nuclear weapon-like devices for testing and training programs.
- Disassemble nuclear weapons for disposal or maintenance purposes.
- Dismantle nuclear weapons no longer required.
- Provide development support to weapons design agencies as requested.
- Store strategic reserve quantities of plutonium.

**Facility Operations.** DOE directs all operations conducted at Pantex. Current missions and functions can be grouped into broad categories of defense program and environmental management activities. No other missions or functions are expected to be added or removed except as described in section 4.5.1 under tritium supply and recycling alternatives for Pantex.

*Defense Program Activities.* The main missions of Pantex are the manufacture of HE components and the assembly/disassembly and maintenance of

nuclear weapons. As previously stated, activities in support of the mission are conducted in portions of the facility referred to as zones. The principal operations performed at Pantex are the assembly of nuclear weapons from components received from other DOE facilities; fabrication of chemical HE components for nuclear weapons; operation of the chemical HE synthesis and characterization group; surveillance testing and disposal of chemical HE; disassembly of obsolete nuclear weapons for retirement; and maintenance, modification, repair, and nonexplosive testing of nuclear weapons components. Weapons assembly and stockpile surveillance activities involve handling significant quantities of uranium components, plutonium components, and tritium components, as well as a variety of nonradioactive toxic chemicals. Brief descriptions of all the above mission activities follow.

HE component production includes manufacturing main charge subassemblies and mock components for use in weapon test assemblies, manufacturing small HE components, producing a variety of explosive materials from chemical reactants and commercially-produced explosives, and evaluating explosive materials and components through a variety of analytical, mechanical, and explosive tests.

New production is defined as the final assembly of a new nuclear weapon to be added to the stockpile. Pantex receives weapons components and other materials from throughout the Complex. The first step in the new production process is the mating of the HE main charge subassemblies and the special nuclear materials, which takes place within an assembly cell. Assembly bays house the remainder of the assembly process. This is where the nuclear subassembly produced in the assembly cell is built into a complete weapon. After final assembly, the items produced at Pantex are shipped either to other facilities within the DOE Complex or to military facilities by truck.

The tasks of modification, maintenance, and repair involve the disassembly of a stockpiled nuclear weapon so that one or more of the components can be repaired, replaced, or modified. After replacing the components, the weapon is reassembled and returned to the stockpile. Activities of this type can be placed into one of the following categories:

- Major Modification—Replacement or modification of such components as the HE charges, the firing sets, or the electrical subassemblies.

- Limited Life Component Exchange—Parts that must be periodically replaced. Some systems require extensive disassembly to accomplish this task. Pantex is responsible for disassembling these weapons, replacing the limited life component and returning the weapons to the stockpile.

- Repairs—Weapons that have sustained damage. An example of such repair is the replacement of mechanical or electrical parts damaged by military users in field locations.

Pantex performs many quality assurance evaluation activities on both new and stockpiled nuclear weapons. These tests involve the disassembly of a weapon, the laboratory testing of various components, and the rebuilding of the weapon for shipment back to the stockpile. Five evaluations are performed at Pantex: New Material Laboratory Testing, New Material Flight Testing, Stockpile Laboratory Testing, Stockpile Flight Testing, and Accelerated Environmental Aging and Materials Compatibility Testing. These evaluations are outlined below:

- New Material Laboratory Testing—Disassembly of a randomly selected newly-produced weapon before it is shipped to the stockpile. Various components are subjected to either destructive or nondestructive tests. After testing, the weapon is rebuilt and shipped to the stockpile.

- New Material Flight Testing—Similar to New Material Laboratory Testing. Units are selected at random before delivery to the stockpile and may be assembled into a nonnuclear, usually nonexplosive, joint test assembly for flight testing. These assemblies are tested aboard aircraft to verify the functioning of the components under in-flight conditions. After the test flight, the unit is returned to Pantex for further examination when possible.

- Stockpile Laboratory Testing—Similar to the New Material Laboratory Testing, but with two major differences. First, Stockpile Laboratory Testing is performed on units randomly selected from the stockpile. Second, some weapons selected for Stockpile Laboratory Testing are not rebuilt after the test, but are disassembled and the components destructively tested to ensure that DOE has an accurate estimate of system reliability.

- Stockpile Flight Testing—Has characteristics of both Stockpile Laboratory Testing and New Material Flight Testing. Components from the selected stockpiled unit are assembled into a joint test assembly for in-flight testing, and undergo similar post-test examination.

- Accelerated Environmental Aging and Material Compatibility—Determines the effects of aging on the integrity of weapon systems over time. These tests involve subjecting newly-produced units to an artificial aging process or to environmental stresses to determine whether or not they retain their chemical and physical properties, and to ensure that they will react in a predictable manner after an extended period of time.

Also, some testing is performed at the Gas Analysis Laboratory, which evaluates samples taken from accelerated aging units, material compatibility tests, development activities, material certification tests, and production operations.

Nuclear weapons no longer needed in the stockpile must be disassembled and disposed of; Pantex accomplishes this in one of the following ways:

- Quality Assurance Disposal—Weapons selected for Stockpile Laboratory Testing that are not to be rebuilt are disposed of. After the parts selected for testing have been removed, the remaining portion of the weapon is disassembled and the parts disposed of after component testing.

- Dismantlement Surveillance—Units selected for disposal in this manner are completely disassembled and selected parts subjected to testing.

- Dismantlement—Dismantlement activities consist of the disassembly of a weapon and the disposition (i.e., staging or destruction) of the components. Limited quality testing and evaluations may be performed.

In addition to the primary efforts associated with weapons assembly/disassembly, disposal, and quality assurance, Pantex provides development support and services to the nuclear weapon design agencies and to other government entities, as requested.

Pantex contains a number of facilities that stage (i.e., temporarily store) weapon components that are destined either for the assembly cells or for shipment back to other DOE facilities. Staging procedures may involve the leak testing of staging containers, inventory procedures to verify the number and contents of containers, and unpacking and repacking to physically verify and test contents.

Assembly and disassembly activities are conducted in Zone 12. There are special nuclear materials staging areas, HE staging and production areas, and component warehouses in Zone 12. Other Zone 12 activities include electrical component testing at the Sandia Systems Test Laboratory located there, as well as administrative office functions, craft shops, the command center, fire station, and other general support facilities such as the cafeteria and sewage treatment.

Stockpile maintenance, testing, disassembly, and disposal missions are conducted in Zones 5 and 12. Zone 4 West is used for staging of weapons and special nuclear materials and interim storage of plutonium pits. Zone 4 East is used for staging of HE and other material. Additional sources of support to the Pantex mission include warehousing and landfill operations in Zone 10, water wells and a water treatment plant in Zone 15, and a vehicle maintenance facility in Zone 16.

The HE development area in Zone 11 consists of facilities for synthesizing and characterizing new HE. HE and HE scrap are disposed of onsite at the burning grounds. The test firing site has several reinforced concrete bunkers containing control rooms and camera areas. Experimental HE configurations are detonated on firing pads surrounded by earthen bunkers. Selected samples of HE components are detonated for quality assurance testing.

*Other Department of Energy Activities.* At present, no other DOE activities are pursued at Pantex.

*Non-Department of Energy Activities.* At present, there are no non-DOE activities pursued at Pantex.

**Environmental Regulatory Setting.** In 1989, the Secretary of Energy invited the host state of each DOE facility to independently determine and verify any plant operational impacts to the environment. In response to this initiative, DOE entered into an Agreement-in-Principle with the State of Texas to focus on waste management, emergency response, and environmental monitoring. DOE provides required information to the State of Texas, and the State conducts sampling and research activities. DOE also issued a Grant-in-Aid for hydrogeologic characterization studies at Pantex.

On September 1, 1993, the Texas legislature created the Texas Natural Resources Conservation Commission and transferred to it the responsibilities of the Texas Water Commission and merged the Texas Air Control Board into the new agency. This agency is now organized to include the Office of Water Resource Management, Office of Air Quality, and Office of Waste Management, among others. Pantex provides office space for Commission officials who are assigned to the plant. EPA has delegated to the State of Texas regulatory authority for air and solid and hazardous waste.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at Pantex. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. On May 31, 1994, EPA placed Pantex on the NPL as a "Superfund Site" pursuant to the provisions of CERCLA. This determination was based on the contamination present due to past practices.

*Air.* The emission of radionuclides from Pantex is regulated under the *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H) by EPA. The standard is that level of emissions of radionuclides that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem or less. The effective dose equivalent to any member of the public from emissions of radionuclides from Pantex in 1993 was less than 1 percent of 10 mrem. To demonstrate compliance with the 40 CFR 61 standard, Pantex performed periodic confirmatory monitoring as prescribed in 40 CFR 61.93 for DOE facilities that emit less than 1 percent of the 10 mrem per year allowable limit.

The Burning Ground, where explosives, explosive components, and explosive-contaminated materials are demilitarized as required by the *Atomic Energy Act,* operates as a RCRA Interim Status Unit and under a written grant of authority from the Texas Natural Resources Conservation Commission. The Burning Ground is also used to thermally treat explosive waste and explosive-contaminated waste. The Texas Natural Resources Conservation Commission has indicated its desire to modify the provisions of this authority. Discussions on the terms of the proposed permit modification between the State of Texas, DOE, and parties to the hearing process are ongoing.

*Water.* The city of Amarillo operates a major water supply well field immediately north and down gradient of Pantex. Pantex also receives its drinking water from the Ogallala aquifer via five groundwater wells located on the northeast corner of the plant. The water is treated onsite and tested in accordance with requirements for public drinking water systems. The domestic water supply at Pantex meets all of the national primary and secondary drinking water standards for non-community, nontransient public water supply systems. On December 20, 1992, Texas Natural Resources Conservation Commission representatives inspected the domestic water supply

system at Pantex. The inspection revealed that the system is being operated and maintained in compliance with Texas statutes and regulations.

Onsite monitoring wells, installed in 1990 between the former chemical burn pit and the Amarillo/Pantex water supply, have not detected any contamination. Other onsite monitoring wells have detected contamination in the upper level or perched aquifer. Pantex no longer releases aqueous waste streams containing hazardous waste or hazardous waste constituents to the land surface. EPA issued DOE a RCRA Administrative Order on Consent effective December 10, 1990, requiring Pantex to conduct a RCRA Facility Investigation to identify, assess, and correct actual and potential threats to human health or the environment resulting from the release or potential release of hazardous wastes or constituents at the facility. DOE completed the RCRA facility investigation and has completed Phase I on 8 work plans and Phase II on one work plan.

In response to a request by the DOE, the EPA determined that an NPDES permit was applicable to operations conducted at Pantex. HE-contaminated wastewater is filtered and treated at individual building filter systems. Most of the filtered water flows into the wastewater lagoon. Since 1980, pursuant to the Texas Water Code, the Texas Natural Resources Conservation Commission has permitted Pantex to discharge its wastewater under a no discharge wastewater permit (Permit Number 02296). No discharge permits allow wastewater discharges not going to "waters of the State." In 1980, the state did not consider playas to be "waters of the State." On December 26, 1990, the DOE filed a permit application to modify its permit. The permit application was resubmitted in May 1992, at the request of the Texas Natural Resources Conservation Commission to change the permit from a no discharge to a discharge permit.

*Land.* Pantex is registered with the State of Texas (Texas Natural Resources Conservation Commission Solid Waste Registration Number 30459) and operates under a hazardous waste permit HW-50284 and EPA Identification Number TX4890110527. Pantex currently operates units both under its hazardous waste permit and under interim status. On April 25, 1991, the Texas Natural Resources Conservation Commission and EPA issued a permit to Pantex to store containers and tanks and to treat hazardous waste in tanks. The permit specifically excluded 17 RCRA units at the Burning Ground, but continued the interim status of those units. Pantex thermally treats explosive waste and explosive-contaminated waste at the Burning Ground. The Burning Ground operates as a RCRA Interim Status Unit and under a written Grant of authority from the Texas Natural Resources Conservation Commission. In November 1991, the DOE formally submitted a request to the Texas Natural Resources Conservation Commission for a Class 3 Modification to add the units at the Burning Ground to the permit. Pursuant to the public notice published on October 31, 1991, interested parties requested a hearing before a hearing examiner on the permit. On May 31, 1992, the Texas Natural Resources Conservation Commission Office of Air Quality, recommended draft hazardous waste permit provisions for the Burning Ground. The Texas Natural Resources Conservation Commission, the DOE, and parties to the hearing process are continuing discussions on terms of the proposed permit modification.

Pursuant to the requirements of the *Federal Facility Compliance Act* of 1992, DOE prepared and submitted to the EPA and Texas Natural Resources Conservation Commission an inventory of all mixed waste stored at Pantex on April 23, 1993. Pantex also submitted a Conceptual Site Treatment Plan to the Texas Natural Resources Conservation Commission in October 1993, as required by the *Federal Facility Compliance Act* of 1992. The Final Site Treatment Plan is to be submitted to the State of Texas by October 1995.

One area of alleged noncompliance resulting from the Texas Natural Resources Conservation Commission RCRA inspection in July 1992, is the storage of mixed waste for a period greater than one year, which is prohibited by the land disposal restrictions. Pantex is addressing the issue of mixed waste storage in its Site Treatment Plan as required by the *Federal Facility Compliance Act* of 1992. The Pantex solution will be finalized in late 1995 upon acceptance by the state of the Site Treatment Plan and state agreement to a resulting Consent Order.

As of December 31, 1993, all equipment and parts used at Pantex that contained PCBs had concentrations of less than 50 parts per million (ppm); thus,

most requirements of the TSCA do not apply. TSCA regulated wastes, including asbestos and materials contaminated with less than 50 ppm PCBs, are transported to permitted facilities for treatment and disposal.

### A.1.5 Savannah River Site

**Site Description.** SRS, 12 miles south of Aiken, SC, and approximately 16 miles southeast of Augusta, GA, occupies 192,000 acres. First established in 1950, SRS has been involved for more than 40 years in tritium operations and other nuclear material production. Today the site contains 15 major production, service, research, and development areas, not all of which are in operation at this time (figure 4.6.1–1).

The developed areas of the site account for less than 5 percent of the land use and more than 99 percent of the total capital investment. There are more than 3,000 facilities at SRS, including 740 buildings, with 5.5 million $ft^2$ of floor area. SRS baseline characteristics are summarized in table 4.6.2.2–1. The following discussion pertains to the active facilities.

The K-Reactor, the last operational reactor at SRS, has been placed into cold standby status with no provision for restart, ending all reactor operations. The other four reactors (C, L, P, and R) already were in cold standby. The Separations Facilities of the 200 area (the largest being the F- and H-Canyons) are located in the center of the site. This area contains approximately 17 major facilities including Waste Management, Defense Waste Processing, Naval Fuel Materials, and Tritium Separations. The new Replacement Tritium Facility, is also located in the separations area. The Central Shops are located in the 600 Area and perform major facility construction activities, while site administration, general support, and many of the research and development facilities are located in the 700 Area.

**Missions.** The current missions of SRS are:

- Tritium recycling.
- Processing Pu-238 for space mission requirements.
- Processing irradiated targets and spent nuclear fuel.
- Interim plutonium storage.
- Waste management.
- Environmental monitoring and restoration.
- Research and development at the Savannah River Technology Center.

**Facility Operations.** SRS is conducting tritium recycling operations in support of stockpile requirements using retired limited life components as the tritium supply source. Some plutonium remaining from the production mission is in interim storage at SRS.

*Defense Program Activities.* SRS conducts tritium recycling operations (tritium bottle recycling) in support of stockpile requirements. The Replacement Tritium Facility assumed this function in fiscal year 1994 operating at 30 to 35 percent capacity, using tritium from returned limited life components. The facility will also assume some of the Nonnuclear Consolidation Plan functional transfers from the Mound Plant. These functions include as a minimum Reservoir Surveillance Operations and Gas Transfer Systems. The Replacement Tritium Facility would also be able to support new-build production requirements, assuming the tritium is available.

Subject to completion of an EIS, the Separation Facilities, the F- and H-Canyons, will assess acceptability of operations for material stabilization until onsite backlogs of fuel and target elements are processed. Upon completion of material stabilization activities, these facilities will be shut down permanently.

*Other Department of Energy Activities.* The Savannah River Technology Center, in Area 700 and at Area TNX provides technical support to all DOE operations at the Savannah River Site. In this role it provides for continued updating and improvement of process efficiency to help reduce costs, waste generation, and radiation exposure. The new Defense Waste Processing Facility, now in the cold test phase, is designed for waste processing, and includes a vitrification plant and incinerator.

*Non-Department of Energy Activities.* There are several facilities and operations at the Savannah River Site which deal mainly with the ecological elements of the site. These are the Savannah River Forest Station, the Savannah River Ecology Laboratory, the South Carolina Wildlife and Marine Resources Department, the Institute of Archaeology and Anthropology, and the Soil Conservation Service.

The Savannah River Forest Station is an administrative unit of the U.S. Forest Service which provides timber management, research support, soil and water protection, wildlife management, secondary road management, and fire management to DOE. The Savannah River Forest Station manages 154,000 acres, or approximately 80 percent of the site area. It has been responsible for reforestation and manages an active timber business. The improvement of the environment has seen an increase in wildlife populations. The station assists with the development and updating of site-wide land use planning and provides continual support with site layout and vegetative management. It also assists in long-term wildlife management and soil rehabilitation projects. This unit occupies buildings on 7 acres. The Senior Community Services Employment Program operated by the Department of Labor is collocated with the station. In addition, there are also offices used by those employed to harvest the timber managed by the station.

The Savannah River Ecology Laboratory is operated for DOE by the Institute of Ecology of the University of Georgia. It has established a center of ecological field research where faculty, staff, and students perform interdisciplinary field research to provide an understanding of the impact of energy technologies on the ecosystems of the southeastern United States. This information is communicated to the scientific community, government agencies, and the general public.

The South Carolina Wildlife and Marine Resources Department manages a program to restore turkeys to their former range throughout the state. The Institute of Archaeology and Anthropology is operated by the University of South Carolina to survey the archaeological resources of the SRS. This survey is used by DOE when planning new facility additions or modifications and is referred to in the operational management of the site. A soil survey report for land use management at the site has been completed.

**Environmental Regulatory Setting.** The South Carolina Department of Health and Environmental Control is the state regulatory agency with authority for air, water, solid waste, mixed, and hazardous waste. DOE and South Carolina signed a Memorandum of Agreement on April 8, 1985, designed to meet both parties' interests in maintaining the environmental qualities on SRS. DOE recognizes South Carolina's delegated authority under CAA, CWA, *Safe Drinking Water Act* SDWA), and RCRA, and agrees to abide by South Carolina environmental laws as would any other industry in the state. South Carolina recognizes that SRS has unique Federal obligations regarding the Federal budget process, NEPA requirements, and classified information. Both parties agreed to a First Amendment to this Memorandum of Agreement on May 5, 1988, stating that DOE shall comply with the South Carolina Underground Storage Tank Regulation.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. This section discusses the more important agreements and other regulatory issues that must be considered before making a reconfiguration decision that would affect SRS.

On December 21, 1989, EPA placed SRS on the NPL as a "Superfund Site" pursuant to the provisions of CERCLA. This determination was based on the contamination present due to past practices.

*Air.* SRS has 14 air quality permits covering 141 point sources for air emissions. According to EPA Region IV, the air monitoring systems at SRS do not adequately provide for monitoring of radionuclide emissions from point sources as specified by *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H), effective December 15, 1989. This requirement states that

emissions of radionuclides from DOE facilities shall not exceed those amounts which would cause any member of the public to receive an effective dose equivalent of 10 mrem per year. In order to determine compliance, DOE must provide for monitoring of radionuclide emissions from point sources with the potential to emit 0.1 mrem per yr. Therefore, DOE and EPA entered into the Federal Facility Compliance Agreement for Radionuclide NESHAP on October 31, 1991, allowing SRS to continue operations and at the same time upgrade facilities to come into compliance with the NESHAP monitoring requirements of 40 CFR 61, Subpart H.

*Water.* SRS has 76 outfalls on a single NPDES permit, SC0000175, which has been administratively extended since 1988. Since 1986, the compliance rate for NPDES regulated discharges has remained above 99 percent. SRS has two other NPDES permits: SC0044903 and one general stormwater discharge permit. A new combined NPDES permit is expected to be issued in 1995.

SRS has documented groundwater contamination. Concentrations of at least one of the following constituents: tritium, gross alpha or trichloroethylene (TCE) in excess of primary drinking water standards were observed in at least one monitoring well at the landfill in the first half of 1989. TCE concentrations up to 400 parts per billion (ppb) have also been detected approximately 800 feet from the SRS boundary. Quarterly status reports of its groundwater quality assessment programs for F-, H-, and M-Areas is required by Administrative Consent Order 85-70-SW dated November 7, 1985, and amended on September 14, 1988. SRS has accomplished all one-time requirements of this order and continues the routine assessment and corrective action as required by the order.

DOE entered into a Settlement Agreement on February 27, 1990, to satisfy violations of discharging wastewater into the environment of the state without a permit. DOE began construction of a Sanitary Wastewater Treatment Plant that will handle effluent discharged from Outfall A008 of the A-Area Powerhouse and other discharges as well. Construction will be completed in 1995.

DOE entered into two settlement agreements under the CWA on June 5, 1990, agreeing to address high temperature discharges and related fish kills. The Thermal Mitigation Settlement Agreement, dated June 5, 1990, alleges failure to comply with both the thermal requirements of the NPDES permit and Consent Order 84-4-W, and requires DOE to address corrective actions for any outfall which exceeds 90 °F. On June 15, 1990, DOE issued the SRS Plan of Study for Minor Thermals to the state and is awaiting approval of the plan that will satisfy this agreement. The Fish Kill Settlement Agreement requires compliance with the Fish Kill Remedial Action Plan submitted by SRS on July 5, 1990, and commented on by the Department of Health and Environmental Control on October 25, 1990, to mitigate high temperature discharges from the L- and P-Reactors which may have resulted in fish kills. On December 12, 1991, South Carolina approved the SRS request to delay remedial actions at Pond C of Par Pond and at the L-Lake due to changes in status of the P-Reactor.

SRS was not able to comply fully with thermal discharge limitations contained in the NPDES permit and, therefore, conducted a thermal mitigation study. The study showed a need for major construction. South Carolina issued Consent Order 84-4-W dated January 3, 1984, which was later amended to require construction of the K-Reactor mitigation alternative not later than December 31, 1992, and to submit a 316(a) plan of study for the D-Area coal-fired facility. The 316(a) study was submitted and is considered conditionally complete. On December 22, 1992, SRS submitted documentation to the state that the K-Reactor mitigation alternative (the cooling tower) had been completed and would allow SRS to discharge K-Reactor cooling effluent in compliance with laws and permit requirements for SRS. Completion of the cooling tower accomplished one of the last thermal mitigation requirements in Consent Order 84-4-W. However, in March 1993, DOE placed the K-Reactor in cold standby with no provision for restart.

*Land.* EPA identified approximately 150 potential operable units and 20 RCRA-regulated units on SRS. In accordance with section 120 of CERCLA, DOE entered into a Federal Facility Agreement effective August 16, 1993, with the EPA and South Carolina to coordinate cleanup activities at SRS under one comprehensive strategy. The Plan also directs interim status corrective action for releases of hazardous

waste or hazardous constituents. The Federal Facility Agreement expands the ongoing RCRA Facility Investigation Program Plan under RCRA Sections 3004(u) and 3004(v) to include those releases as a CERCLA cleanup which are not already included in the RCRA *Hazardous Waste Management Act* permit.

The purposes of the Federal Facility Agreement are to:

- Meet the requirements of CERCLA for an interagency agreement and assure compliance with Federal and state hazardous waste laws for matters covered by this agreement.
- Provide for state involvement in the initiation, development, selection, and enforcement of corrective/remedial actions.
- Identify operable units for investigation and possible corrective/remedial action.
- Establish requirements for the performance of investigations to determine fully the nature and extent of the threat to the public health or welfare.
- Identify the nature, objective and schedule of response actions to be taken at SRS; establish a basis for a determination that the DOE has completed the remedial actions required.
- Establish requirements for the SRS high-level radioactive waste tank system to ensure structural integrity, containment and detection of releases.

SRS has further agreed in the Federal Facility Agreement to ensure structural integrity, containment and detection of releases, and source control for the SRS high-level radioactive waste tank systems identified in Appendix B of the agreement. SRS will also develop a process to review the risk associated with each of the regulated single-wall storage tanks on a tank-by-tank basis. This process will result in a tank removal or abandonment program which is protective of human health and the environment and which is in compliance with the provisions of RCRA (40 CFR 264, Subpart J), the agreement, and all other applicable regulations. According to the Waste Removal Plan and Schedule submitted to the state on November 15, 1993, the schedule to remove waste from the tanks that do not meet secondary containment requirements is the year 2028. Radioactive waste is contained in 23 of the underground storage tanks. Further construction of the single-wall type tank for storage of radioactive waste is prohibited by the Federal Facility Agreement. SRS must meet storage tank/container standards in 40 CFR 264 and provide a schedule for submitting complete RCRA permit applications for new facilities to come on line. Schedules have been agreed upon within the Federal Facility Agreement to provide compliance through construction of treatment facilities and other measures.

The Federal Facility Compliance Agreement signed by EPA and DOE on March 13, 1991, addresses SRS compliance with the Land Disposal Restrictions of the Hazardous and Solid Waste Amendments of 1984 pertaining to past, ongoing, and future generation of mixed wastes (mostly solvents, dioxin and California list wastes contaminated with radioactive tritium from rags and wipes used to remove radioactive-contaminated and nonradioactive solvents and wastes from equipment), that are prohibited from land disposal without treatment to standards. This Federal Facility Compliance Agreement supersedes the July 30, 1987, Federal Facility Compliance Agreement for Past Disposal at the Mixed Waste Management Facility and incorporates any remaining provisions in addition to the new requirements. In this agreement, the parties agreed that the high-level mixed waste in the tank farms must be allowed to decay to an appropriate level of radioactivity before processing at the Defense Waste Processing Facility and that such aging shall be considered an accumulation of such quantities of hazardous waste as is necessary to facilitate proper treatment, recovery or disposal so long as the other requirements contained in 40 CFR 268.50 are met.

The Federal Facility Compliance Agreement allows SRS to continue to operate, generate, and store mixed wastes subject to the Land Disposal Restrictions and outlines a plan for mixed waste compliance that, when approved by South Carolina, would allow SRS to come into compliance with the mixed waste

storage provisions of the *Federal Facility Compliance Act* of 1992. In return, SRS will report to EPA the characterization of all solid waste steams disposed in land disposal units at the SRS, will identify within 60 days any new hazardous waste streams introduced, and will submit a plan for waste minimization to EPA for review. DOE submitted the required waste minimization plan on time. SRS is also required to segregate restricted wastes, excluding those previously located on the TRU storage pads, from other mixed wastes and report on a recurring basis the identity, quantity, and compliance problems associated with restricted mixed wastes and the impact of Land Disposal Restrictions requirements.

Under the provisions of the Federal Facility Compliance Agreement, SRS agreed to report construction and operational data and waste processing milestones for the Consolidated Incineration Facility, Defense Waste Processing Facility, and other hazardous waste storage, treatment, and disposal facilities planned to be built at SRS. This reporting is required because their use is key to long-term compliance with Land Disposal Restrictions for mixed waste. SRS is required to prepare TRU waste for shipment to WIPP, but the agreement allows continued storage of certified TRU waste at the TRU waste storage pads until its suitability has been determined pursuant to the provisions of 40 CFR 191 and 40 CFR 268 and it can be shipped to WIPP. In addition, DOE agreed to provide EPA with an annual progress report on WIPP, and this agreement must be modified if DOE determines that no TRU waste will be shipped from SRS by July 30, 1999. Finally, SRS agreed to provide hazardous waste training to EPA Region IV employees. On April 24, 1992, the agreement was amended to include Third Thirds restricted wastes and an alternative treatment strategy for M-Area waste. The periodic reporting requirements of the original agreement were also amended.

On September 30, 1987, the South Carolina Department of Health and Environmental Control issued the RCRA Part B Permit (RCRA SC1890008989) that granted final status to four hazardous waste storage buildings and approved a postclosure plan for the M-Area Settling Basin and vicinity. The RCRA permit requires SRS to assess and, where necessary, take appropriate corrective action for any releases of hazardous wastes. Additional hazardous waste facilities, subject to RCRA interim status when the permit was approved, have been added to the RCRA permit.

In January 1990, DOE notified the South Carolina Department of Health and Environmental Control that rags and wipes used with F-listed solvents for cleaning and for radioactive decontamination had been disposed in portions of the Low-Level Radioactive Waste Disposal Facility and in the SRS Sanitary Landfill. The Department of Health and Environmental Control advised DOE and SRS that certain solvent rags and wipes constituted hazardous waste subject to South Carolina Hazardous Waste Management Act regulation. As a result, DOE and South Carolina signed Settlement Agreement 91-51-SW effective August 26, 1991, to satisfy South Carolina allegations that SRS failed to comply with interim status standards for operation of the Low-Level Radioactive Waste Disposal Facility and the sanitary landfill in the disposal of spent solvent wastes without having applied for or received a permit for operation of these units. SRS agreed to refrain from further disposal of F-listed solvent contaminated rags and wipes in the Low-Level Radioactive Waste Disposal Facility and sanitary landfill or any other facility not specifically permitted for such disposal.

An SRS Public Involvement Plan has been designed to facilitate public involvement in decision-making processes for permitting, closure, and selection of remedial alternatives. The plan addresses the requirements of CERCLA, RCRA, and NEPA, and forms the basis for continued involvement of stakeholders at SRS. As envisioned by the revised plan, SRS has formed a Citizen's Advisory Board to further public involvement.

Currently, SRS is storing PCB-contaminated equipment and cleanup materials for which, due to their radioactive nature, treatment is not currently available. DOE is presently developing this treatment capability and SRS intends to store these PCB-contaminated radioactive equipment and materials onsite until such time as appropriate disposal methods, treatment capacity, and facilities become available. Currently, SRS is storing these PCB-contaminated radioactive materials in an onsite facility that meets storage requirements under 40 CFR 761, but is out of compliance with the provision requiring removal of PCB-contaminated wastes from storage and their disposal within one year. As at

other DOE sites, DOE is presently working with EPA to approve a treatability study to remove the PCB contamination and the radioactive materials from SRS as LLW.

## A.2 PROJECT DESCRIPTIONS

This section contains detailed descriptions of the individual tritium supply and recycling technologies being evaluated in this PEIS. Each supply technology description represents a new facility and the recycling descriptions represent either new or upgraded facilities whose impacts are being considered in evaluating the program alternatives.

Design bases for each of the tritium supply technology options have been previously developed and are as follows:

- Heavy Water Reactor (HWR)—All requirement documents developed in the New Production Reactor program for the HWR.
- Modular High Temperature Gas-Cooled Reactor (MHTGR). All requirement documents developed in the New Production Reactor program for the MHTGR.
- Advanced Light Water Reactor (ALWR)—All requirements developed for the New Production Reactor program and the data, as gathered, from the Surplus Fissile Materials program.
- Accelerator Production of Tritium (APT)—All requirement documents developed in the Tritium Supply and Recycling program for the APT as amended.

Each of the facility designs will, to the extent possible, incorporate the following objectives: maximum operational efficiency, ability to incorporate future technological advances, and ability to meet changing operating requirements. The upgrades/modifications option is designed to renovate existing tritium recycling facilities at SRS to meet mission requirements while complying with all ES&H criteria.

The conceptual designs described in the following sections for the various tritium supply and recycling facilities were based on the following assumptions:

- The design would be based on a normal production rate to meet anticipated baseline tritium requirements (3/8 New Production Reactor goals).
- The enduring stockpile would consist of a mix of systems equivalent to the following existing weapons programs: B53, B61, B83, W76, W78, W80, W87, and W88.
- The facilities would be designed to produce only materials or components required for nuclear weapons programs. The exception is the tritium recycling facility, which would provide tritium for commercial sales.
- The tritium facilities would be capable of producing materials and assembling new building components for two weapon systems in any given year. This capability would be achieved by either simultaneous or sequential campaigns, as long as the sum of the product shipments for the year meets the annual production goals.

### A.2.1 Tritium Supply

Tritium, a radioactive form of hydrogen gas, is an essential component of all the warheads in the existing and projected nuclear weapons stockpile. Since it decays at a rate of 5.5 percent per year (12.3-year half-life), the tritium in fielded weapons must be replenished periodically. In addition, because of its decay, the existing national inventory of tritium will become insufficient to meet projected nuclear weapon stockpile requirements around the end of the next decade. This means that a source of new tritium will be needed to prevent degradation of the national nuclear deterrent capability.

The last operating tritium supply reactor, K-Reactor at SRS, has been placed in cold standby with no planned provision for restart. Therefore, DOE is evaluating the construction of a new tritium supply facility. There are a number of candidate tritium production technologies under consideration that could fulfill this mission. Each of these technologies has strengths and weaknesses that are dependent on:

selected site, tritium production capacity and/or, supporting infrastructure. The technologies under consideration are listed below and will be discussed in the following sections:

- HWR;
- MHTGR;
- ALWR; and
- Linear Induction Accelerator, herein after referred to as APT.

### A.2.1.1 *Heavy Water Reactor*

**Mission.** The primary mission of the HWR facility would be to provide the full range of tritium supply functions performed by DOE, as well as waste treatment functions related to HWR operations.

**Assumptions.** The assumptions used in the design of this facility are listed in section A.2.

**General Functions and Layout.** The HWR facility would produce tritium by bombarding an isotope of the element lithium with neutrons produced by nuclear fission reactions in uranium. The interaction of neutrons with the lithium creates an unstable lithium isotope that decays almost instantaneously to tritium and an alpha particle. The HWR facility would consist of the following major components: the reactor, target and fuel fabrication, tritium target processing, interim spent nuclear fuel storage, general service, and waste treatment. Figure A.2.1.1–1 depicts the HWR tritium production process and figure A.2.1.1–2 shows the HWR facility site plan. This figure shows a mechanical draft cooling tower system.

**Component Facility Functions.**

*Reactor.* The reactor would be based on a low-pressure, low-temperature application of nuclear fission technology specifically designed to produce tritium. The reactor vessel and cooling system configuration (with primary and secondary cooling loops) would be similar to that used in commercial light water reactor nuclear power technology. The HWR would use heavy water as the reactor coolant and moderator. Heavy water, circulated through the core for cooling and moderation, also passes through heat exchangers that are external to the reactor tank. The heat is in turn carried away by the secondary cooling system. The heavy water in the tank surrounding the fuel would represent the bulk moderator. Less than 10 percent of the reactor heat would be generated in the moderator space because of gamma heating; the bulk of the heat would be generated in the core.

The major engineered safety features would include the reactor containment building; the emergency core cooling system to provide makeup coolant flow heat removal for an extended period, following either a loss-of-coolant accident or a loss-of-pumping accident; emergency shutdown safety rods independent of the control rods; neutron poison injection of gadolinium nitrate into the moderator space of the reactor tank; and a backup residual heat removal system capable of removing decay heat from the reactor if the primary coolant fails to circulate.

Engineered safety features of the HWR also include natural circulation cooling by the primary and secondary coolant systems and the boiling pot mode. The boiling pot mode would occur by circulation through the core of the water in which the system is submerged following complete discharge of the Borated Light-Water Reactor Storage Tank; the core will be cooled by a two-phase flow. Steam generated by this process condenses on the containment shell and interior structures. The condensate replenishes the water at the bottom of the containment. The containment shell is cooled by convective flow of outside air which flows between the steel containment and the concrete shield. All the engineered safety features combined would provide a "walk-away" design of the HWR to prevent and/or mitigate a beyond design basis accident event (severe accident).

A circulating ventilation system with atmospheric driers would be used to collect and control tritiated water vapor during normal operation, thus reducing leakage of tritium. The containment system would include such features as heat removal sprays, hydrogen igniters, and long-term residual heat removal systems to mitigate potential radiological releases under severe accident conditions. The initial heavy water inventory for an HWR is available from existing inventories at SRS.

Because of the relatively low exit coolant temperature in the HWR, a power conversion system would

not be feasible. The heat dissipation system would ensure that the reactor is cooled by the flow of water circulated through the core in a closed primary loop under pressure through the reactor vessel and through coolant pipes connected in parallel to heat exchangers. The heat dissipation system selected, wet or dry, would be dependent on site characteristics. Both wet and dry cooling systems would use water as the heat exchange medium. Wet systems would use water towers and the evaporation process to carry off heat. Dry systems, designed for cold climates, would use water in closed nonevaporative cooling towers to carry off heat to the atmosphere by conduction through radiator-like vanes. In moderate climates, fans would be added to the dry cooling towers to move air over the vanes. There would be some water loss through evaporation in a dry system, but significantly less than with a wet tower. Dry cooling towers would be used for the reactors at all dry sites.

*Target and Fuel Fabrication Facility.* The concentric tubes of lithium-aluminum and of uranium-aluminum would be fabricated and assembled into tritium target/fuel assemblies in the target and fuel fabrication facility. The facility would include areas for alloying, casting, machining, extrusion, inspection, and assembly. Auxiliary services would include a maintenance shop, an electronic and instrumentation shop, offices, and a metallurgical and chemical laboratory. There would also be several small storage buildings nearby for lithium and aluminum components. The facility would be designed to control the spread of contamination and prevent the uncontrolled release of radioactive material to the environment.

*Tritium Target Processing Facility.* After irradiation and cooling in the spent fuel pool, the tritium target tubes would be withdrawn from the assemblies and sent to the tritium target processing facility for tritium extraction. The facility would house the processes, laboratory, and other activities associated with tritium handling. Most of the process operations and hot laboratory analyses would be performed in nitrogen-blanketed gloveboxes to ensure tritium containment. The hot cell would contain two or more vacuum furnaces for extracting tritium from the irradiated targets. Airlocks would separate the furnaces from the rest of the hot cell.

*Interim Spent Nuclear Fuel Storage Facility.* Spent nuclear fuel would be sent to, and stored underwater at, the interim spent fuel storage facility.

*General Service Facility.* The general service facility would contain the control equipment and various plant support equipment.

*Waste Treatment Facility.* The waste treatment facility would receive all solid, liquid, and gaseous radioactive waste for storage, treatment, and packaging for either release or disposal at an appropriate permanent waste disposal facility.

**Description of Processes.**

*Tritium Target and Fuel Production.* Lithium-aluminum tritium target alloy would be formed into billets and preextruded into logs which would then be machined and nested into coextrusion billets. These billets would then be coextruded to produce the target tubes. The uranium-aluminum fuel alloy would be similarly formed into fuel tubes and then nested with the target tubes into the tritium target/fuel assemblies described earlier.

*Tritium Production.* The tritium target/fuel assemblies would be loaded into the reactor and irradiated. When the irradiation is complete, the assemblies would be removed and shipped to the disassembly basin.

*Tritium Extraction.* At the disassembly basin, the target tubes would be separated from the fuel tubes and allowed to cool so that short-lived isotopes could decay. A 1-month cooling period for tritium targets is assumed. After cooling, the target tubes would be washed within the shielded transport cask, then placed in a crucible, inserted into a furnace, and heated to drive off the gases, including the tritium product. The gas stream from the furnace, mainly helium and hydrogen isotopes, including tritium, would pass through a diffusing process to separate the hydrogen isotopes from helium and other impurities. This process would cycle the gas between two beds of treated diatomaceous earth used as a filter aid. One bed would be heated to drive off the gases; the other bed would be cooled to promote gas absorption. The purified tritium would be sent to the tritium recycling facility, where tritium reservoirs are filled.

**Facility Utilities.** Facility construction and operation utility requirements are shown in tables A.2.1.1–1 and A.2.1.1–2, respectively.

**Chemicals Required.** Table A.2.1.1–3 depicts chemical resources required during operation.

**Personnel Requirements.** Construction of the HWR would have a peak employment of 2,320 construction workers. Approximately 9,760 worker years would be needed during the 8-year construction period. Operation of the HWR would require 930 workers with 230 of these badged for radiation detection.

**Transportation.** Interfacility transfers would be made by rail, truck transport, or pipeline, as appropriate. Truck service would be needed for intrafacility transport.

**Waste Management.** The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in Department of Transportation (DOT) approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The facility design considers and incorporates waste minimization and pollution prevention. Activities that generate radioactive and hazardous wastes would be segregated, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that generate hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations would also be incorporated into the design.

Table A.2.1.1–4 presents the estimated annual spent nuclear fuel and waste volumes from the HWR facility during construction and operation. Solid and liquid waste streams would be routed to the waste management system. Figure A.2.1.1–3 depicts the waste management system at a dry site while figure A.2.1.1–4 illustrates the waste management system for a wet site. Solid wastes would be characterized and segregated into LLW, hazardous, and mixed wastes, then treated to forms suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

*Spent Nuclear Fuel.* Spent nuclear fuel would not be reprocessed. Spent nuclear fuel would be initially stored at the spent nuclear fuel storage facility in pools onsite. After the spent nuclear fuel decay heat has decreased sufficiently (approximately 230 days), the nested fuel tubes from four spent nuclear fuel assemblies would be loaded into stainless steel containers in the disassembly area. The loaded containers would be dewatered by displacement with air or an inert gas such as helium or argon and then sealed. The sealed containers would then be transferred to an interim onsite dry storage basin for horizontal emplacement on racks with poison plate separators. The facility design would have sufficient capacity to store the spent nuclear fuel for the life of the facility. The interim management of spent nuclear fuel (pending availability of a geologic repository) would be in accordance with the Record of Decision (ROD) from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement.*

*Transuranic Waste.* The HWR would not generate any TRU waste.

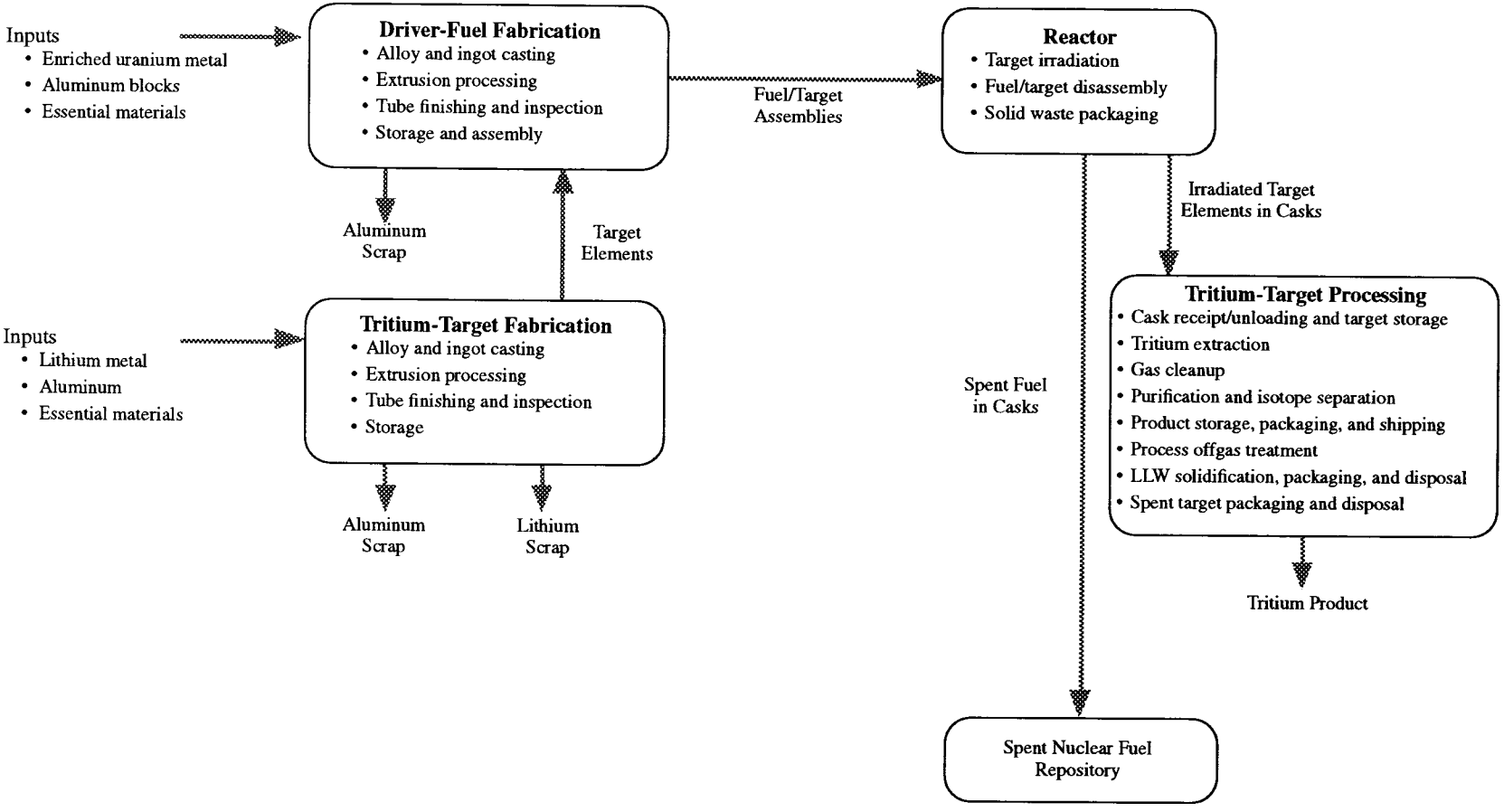
*Low-Level Waste.* LLW would be generated by the operation of the reactor and support facilities. The aqueous releases from fuel and tritium-target fabrication would be liquid LLW from tube-cleaning operations. Process effluents would be temporarily held in storage tanks before treatment into solid LLW that is suitable for LLW disposal. The nonhazardous liquid effluent would then be discharged through a permitted NPDES outfall. The bulk of the solid LLW would be generated in the reactor, fuel fabrication, and tritium target processing facilities. Solid LLW would consist of contaminated equipment pieces, plastic sheeting, protective clothing, solidified slurry from the wastewater treatment facility, spent high efficiency particulate air (HEPA) filters, spent targets, spent catalysts and resins, and spent uranium beds. Solid LLW would be compacted as appropriate and then disposed of in a suitable disposal facility.

*Mixed Low-Level Waste.* No liquid mixed LLW would be generated from the HWR facility. Solid mixed LLW may originate from wipes laden with contaminated oils and hydraulic fluids from the tritium extraction facility. Mixed LLW would be stored in an onsite RCRA-permitted storage facility until treatment in accordance with the site-specific treatment plan that was developed to comply with the *Federal Facility Compliance Act* of 1992.

*Hazardous Waste.* Liquid hazardous wastes would be generated from degreasing agents, cleaning solvents, cutting oils, vacuum pump oils, film processing fluids, hydraulic fluids from mechanical equipment, antifreeze solutions, and paint. The cleaning solvent selected would be from a list of nonhalogenated solvents. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters. Solid hazardous wastes would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

*Nonhazardous Waste.* Sewage wastewater would be treated in the sanitary wastewater treatment plant. Sewage wastewater is kept separate from all industrial and process wastewaters and normally contains no radioactive wastes from the facility. The sewage wastewater would be routinely monitored for radioactive contaminants. The sewage process sludge would be disposed of in a permitted landfill. All treated effluent would be discharged to a stream or river through an NPDES outfall (wet site) or a natural drainage channel (dry site). Cooling system blowdown would be treated and discharged to the river (wet site). Because the dry site design uses non-evaporative-type cooling towers, there would be no liquid discharges resulting from blowdown. The treated effluent from the utility wastewater treatment would be discharged to the river through an NPDES outfall (wet site) or a natural drainage channel. All sludges would be disposed of in a permitted landfill. Other nonrecyclable, solid, nonhazardous sanitary and industrial wastes would be compacted and disposed of in a permitted landfill.

The facility design includes stormwater retention facilities with the necessary NPDES monitoring equipment. Rainfall within the Limited Area and Protected Area would be collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge to the natural drainage channels (dry site) or river (wet site). If the runoff is contaminated, it would be treated in the radioactive waste treatment system. Runoff from the Property Protection Area would be discharged directly into the natural drainage channels or river.




Source: DOE 1992o:4.

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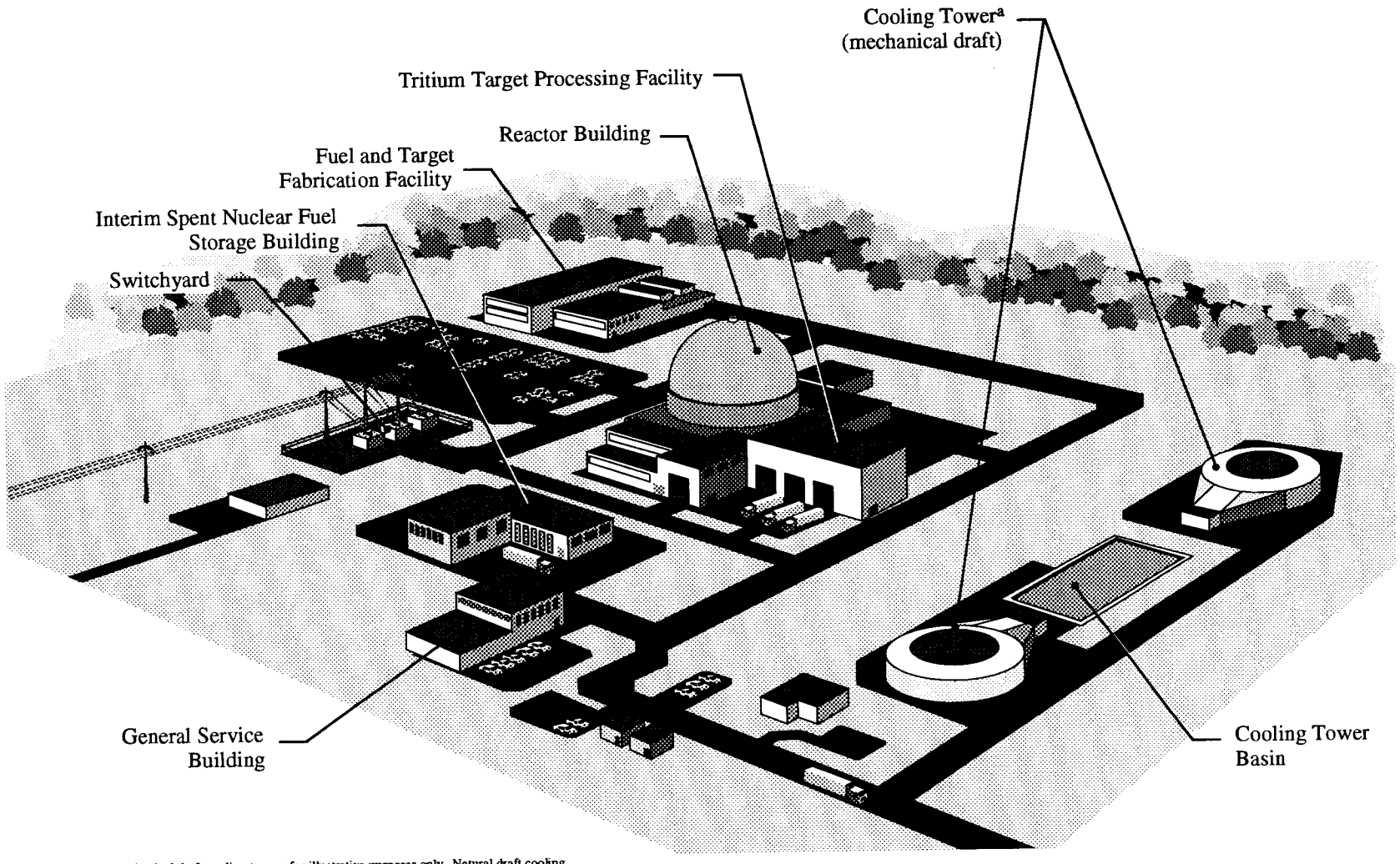
**FIGURE A.2.1.1–1.—*Heavy Water Reactor Tritium Production Process.***




[a] This figure shows mechanical draft cooling towers for illustrative purposes only. Natural draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995d.

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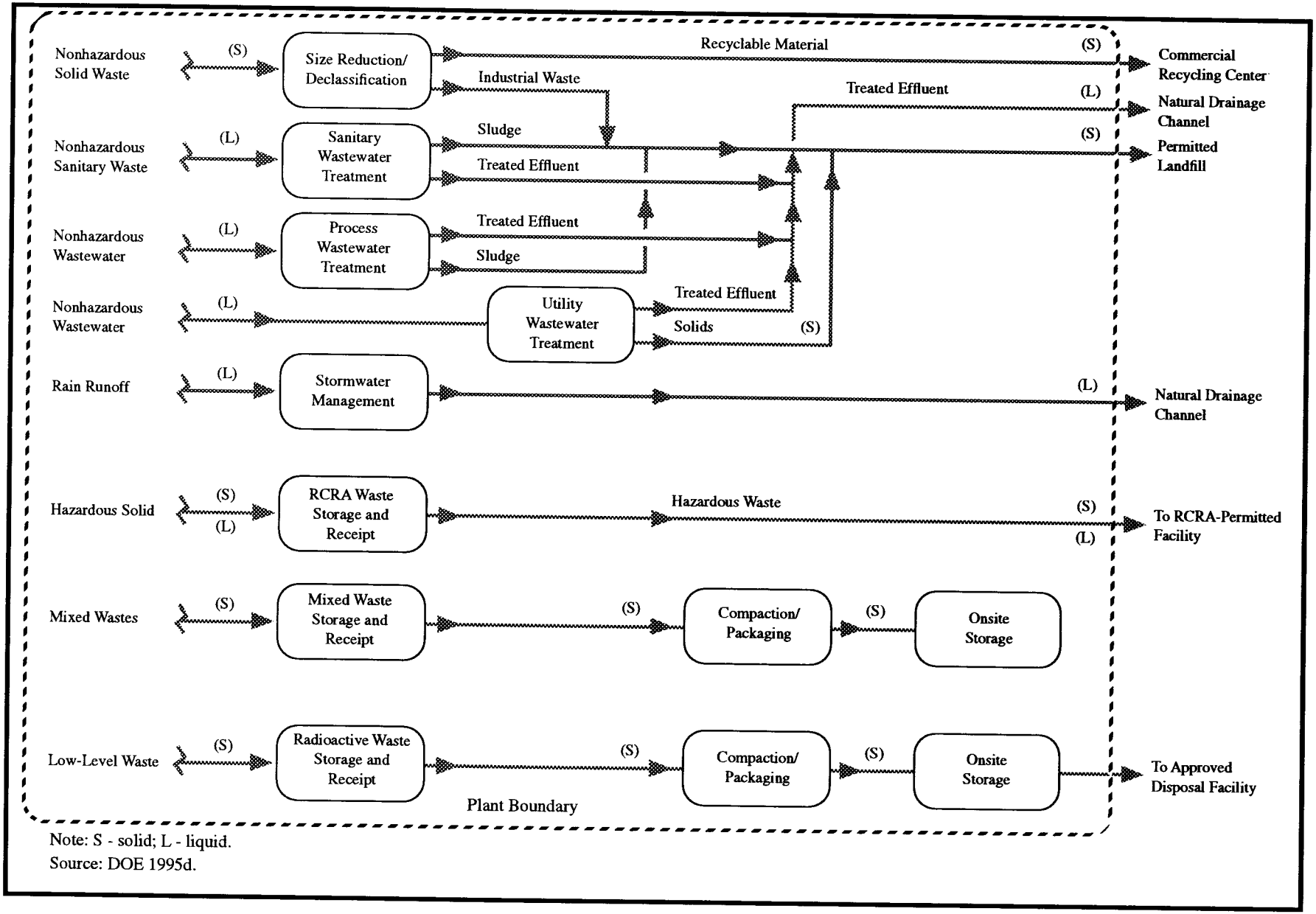
**FIGURE A.2.1.1–2.—*Heavy Water Reactor Facility (Typical).***




Note: S - solid; L - liquid.
Source: DOE 1995d.

**FIGURE A.2.1.1–3.—*Heavy Water Reactor Waste Management System (Dry Site).***

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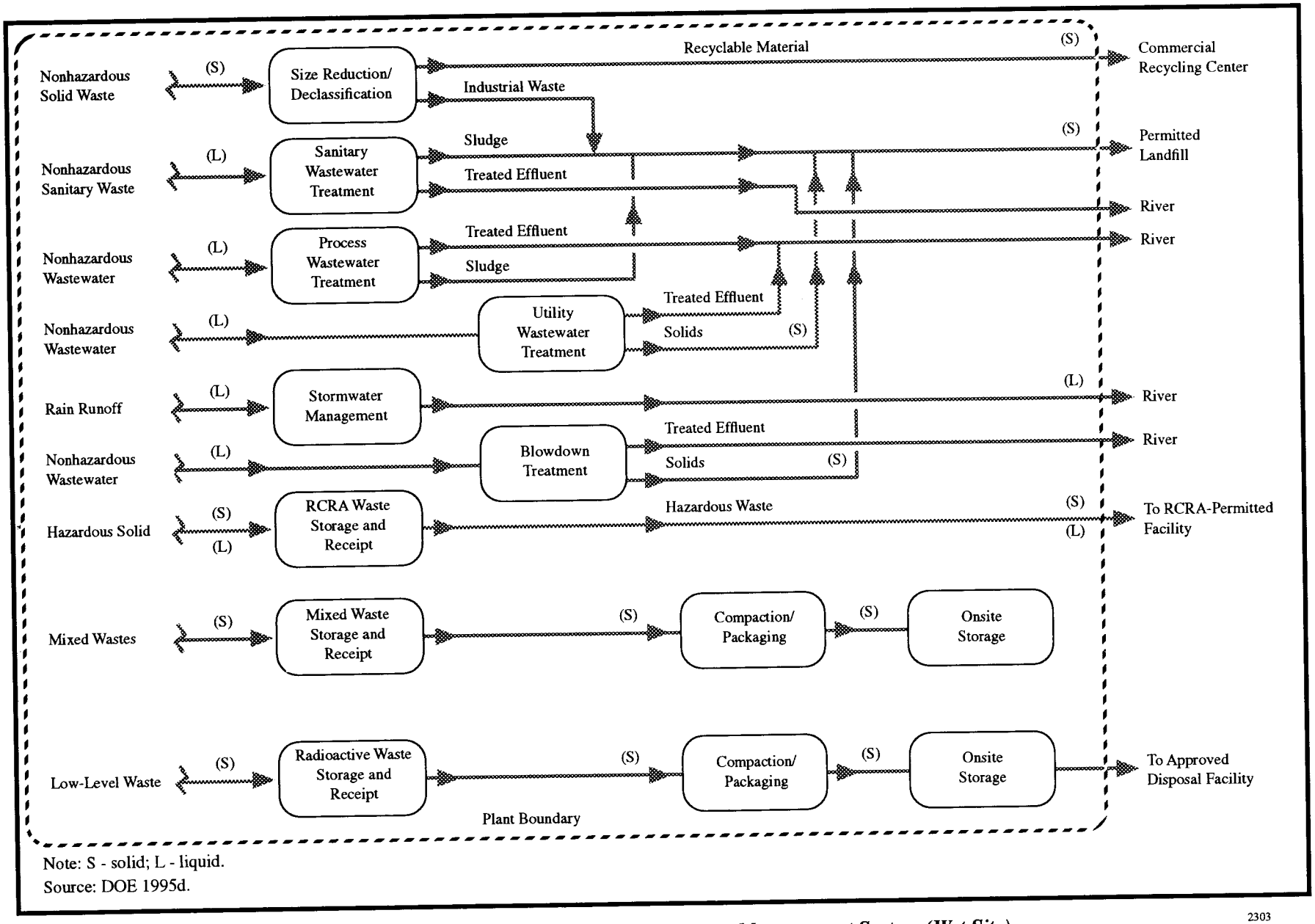



Note: S - solid; L - liquid.
Source: DOE 1995d.

**FIGURE A.2.1.1–4.—*Heavy Water Reactor Waste Management System (Wet Site).***

**TABLE A.2.1.1–1.—*Heavy Water Reactor Construction Material/Resource Requirements***

| Material/Resource | Consumption |
|---|---|
| Electrical Energy (MWh) | 87,000 |
| Concrete ($yd^3$) | 220,000 |
| Steel (tons) | 45,000 |
| Fuel (gal) | 2,400,000 |
| Water (gal) | 170,000,000 |

Source: DOE 1995d.

**TABLE A.2.1.1–2.—*Heavy Water Reactor Operation Utility Requirements***

| Utility | Consumption |
|---|---|
| **Electrical Energy (MWh per year)** | |
| Wet site | 370,000 |
| Dry site | 540,000 |
| **Electrical Load (MWe)** | |
| Wet site | 51 |
| Dry site | 69 |
| **Fuel** | |
| Gas ($ft^3$ per year) | 240,000,000 |
| Liquid (GPY) | 82,000 |
| **Water (MGY)** | |
| Wet site | 5,900 |
| Dry site | 48 |

Source: DOE 1995d.

**TABLE A.2.1.1–3.—*Heavy Water Reactor Annual Chemical Requirements***

| Chemicals | Quantity (tons) |
|---|---|
| Aluminum | 12 |
| Uranium metal | 0.75 |
| Lithium metal | 0.08 |
| Stainless steel | 0.125 |
| Nitric acid | 1.2 |
| Sodium hydroxide | 0 |
| Sulfuric acid | 0 |

Source: DOE 1995d.

TABLE A.2.1.1–4.—*Heavy Water Reactor Estimated Spent Nuclear Fuel and Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Dry Site: Annual Volume Generated From Operations ($yd^3$) | Dry Site: Annual Volume Effluent From Operations ($yd^3$) | Wet Site: Annual Volume Generated From Operations ($yd^3$) | Wet Site: Annual Volume Effluent From Operations ($yd^3$) |
|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | 7 | 7 | 7 | 7 |
| **Low-Level** | | | | | |
| Liquid | None | 10,400[a] (2,100,000 gal) | None | 10,400[a] (2,100,000 gal) | None |
| Solid | None | 5,200 | 1,870[b] | 5,200 | 1,870[b] |
| **Mixed Low-Level** | | | | | |
| Liquid | None | None | None | None | None |
| Solid | None | 120 | 120 | 120 | 120 |
| **Hazardous** | | | | | |
| Liquid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid |
| Solid | 20 | 40 | 40 | 40 | 40 |
| **Nonhazardous (Sanitary)** | | | | | |
| Liquid | 79,220 (16,000,000 gal) | 238,000 (48,000,000 gal) | 238,000 (48,000,000 gal) | 11,600,000 (2,350,000,000 gal) | 11,600,000 (2,350,000,000 gal) |
| Solid | 7,800 | 7,600 | 2,530[c] | 7,600 | 2,530[c] |
| **Nonhazardous (Other)** | | | | | |
| Liquid | 2,570[d] (520,000 gal) | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 6,500[e] | None | 6,500[e] | None |

[a] Liquid LLW is treated with the remaining LLW sludge being solidified.

[b] Assumes a 100:1 wastewater/sludge ratio in the treatment of liquid LLW, followed by 2:1 increase in volume from solidification of sludge. Assumes compaction factor of 3:1 for compactible solids.

[c] Assumes overall compaction factor of 3:1.

[d] Does not include groundwater dewatering, if required.

[e] Recyclable wastes.

Source: DOE 1995d.

### A.2.1.2 *Modular High Temperature Gas-Cooled Reactor*

**Mission.** The primary mission of the MHTGR facility would be to provide the full range of tritium supply functions performed by DOE, as well as waste treatment functions related to MHTGR operations.

**Assumptions.** The assumptions used in the design of this facility are listed in section A.2.

**General Functions and Layout.** The MHTGR would produce tritium by bombarding an isotope of the element lithium with neutrons produced by nuclear fission reactions in uranium. The interaction of neutrons with the lithium creates an unstable lithium isotope that decays almost instantaneously to tritium and an alpha particle. The MHTGR facility would consist of the following components: the specified number of reactors (three reactors are analyzed in this PEIS), target and fuel fabrication, tritium target processing, interim spent fuel storage, general service, waste treatment, and power conversion. Figure A.2.1.2–1 depicts the MHTGR tritium production process while figure A.2.1.2–2 shows the MHTGR facility site plan.

**Component Facility Functions.** The MHTGR would be sized (i.e., the number of reactors) and designed for a specific tritium supply capability based on reasonably foreseeable long-term requirements.

*Reactor.* Each individual reactor would be a moderate pressure, high temperature device designed to produce tritium. A reactor includes its vessel, a steam generator, a helium circulator, and interconnecting cross ducts housed in the reinforced concrete containment structure. The reactor vessel would contain the core, control rods and drives, the reflector, and the core supports. Top-mounted standpipes would house the control rod drives and the reserve shutdown system. A shutdown circulator mounted at the bottom of the core would provide cooling when the main circulator is out of service for maintenance. The core size and shape provide for natural convection heat transfer through to the pressure vessel walls in the event of the loss of circulation or if the pressure boundary were breached for any reason. Core power would be controlled by moveable control rods containing boron carbide as a nuclear poison. Reserve shutdown would consist of boron carbide spheres normally contained in hoppers above the core. When needed, they would be dropped into holes in the fuel blocks, shutting down the nuclear reaction.

Helium would be used as the coolant and graphite would provide the core structure and act as moderator. The coolant would be pumped by an electrically driven circulator located above the core. The reactor core would be housed in a steel pressure vessel. Short ducts would direct the helium to the steam generators. The helium heated by the core would flow over the steam generator tube bundle, giving up its heat to the feedwater, and producing superheated steam. This steam would be of sufficient quality that it could be used for the production of electricity. When shut down for maintenance or refueling, the decay heat of the core would be removed either by the normal cooling system, or by the shutdown cooling system, with its own circulator and independent heat exchanger.

In the event of transients that would increase reactor fuel temperature, the increased temperature would decrease the power level. This would work two ways in that the mass of the core would absorb the additional heat generated, and as the temperature gradually rises, power would decrease. Even in the event of the loss of coolant at full power, the reactor would return to a lower temperature, core geometry would be maintained, and control rod insertion would not be hampered. Predictable reactor response and long time constants are a product of the high heat capacity of the core and the lack of phase changes in the primary coolant. All this would occur without the need for operator intervention.

The heat dissipation system selected, wet or dry, would depend on site characteristics. Both wet and dry cooling systems would use water as the heat exchange medium. Wet systems would use water towers and the evaporation process to carry off heat. Dry systems, designed for cold climates, would use water in closed nonevaporative cooling towers to carry off heat by conduction to the atmosphere through radiator-like vanes. In moderate climates, fans would be added to the dry cooling towers to move air over these vanes. There would be some water loss through evaporation in a dry system, but significantly less than with a wet tower. Dry cooling towers would be used for the reactors at all dry sites.

The use of wet cooling towers would be an option only for the power conversion facility and only when the facility would be located at a wet site.

*Target and Fuel Fabrication Facility.* The target and fuel rods would be assembled for irradiation in the reactor. After irradiation, the assemblies would be returned for separation of the target and fuel rods.

*Tritium Target Processing Facility.* Spent nuclear fuel rods would be sent to interim storage and the target rods would be sent to the tritium processing facility, which houses the processes, laboratory, and other activities associated with the production of tritium gas including a hot cell for receiving, storing, and processing irradiated target rods.

*Interim Spent Nuclear Fuel Storage Facility.* This facility, consisting of three fuel pool bays paired with individual reactors, would allow underwater storage of spent nuclear fuel elements.

*Power Conversion Facility.* This facility would consist of a fully independent turbine generator for each reactor. It would also include a maintenance building, makeup water treatment and auxiliary boiler building, station cooling towers, station transformers, circulating water pumphouse, and electric switchyard.

*General Service Facility.* This facility would contain the control equipment and various plant support equipment.

*Waste Treatment Facility.* This facility would receive all solid, liquid, and gaseous radioactive waste for storage, treatment, and packaging for either release or disposal at an appropriate permanent waste disposal facility.

**Descriptions of Processes.**

*Tritium Target Fabrication.* Targets would be fabricated from pyrocarbon-coated lithium aluminate microspheres. The compacts would be loaded into graphite sleeves that are subsequently loaded into graphite blocks similar to those used to hold the fuel rods.

*Tritium Production.* The fuel and target blocks would be loaded into the reactor and irradiated. When the irradiation is complete, the blocks would be removed and the target compacts would be separated from the fuel and sent to the tritium extraction facility for further processing.

*Tritium Extraction.* The tritium in the irradiated target compacts would be extracted by heating and captured by chemical absorption. The spent targets would be disposed of as waste. The tritium would be transferred to the tritium recycling facility.

**Facility Utilities.** Facility construction and operation utility requirements are shown in tables A.2.1.2–1 and A.2.1.2–2 respectively.

**Chemicals Required.** Table A.2.1.2–3 lists chemical resources required during operation.

**Personnel Requirements.** Construction of the MHTGR would have a peak employment of 2,210 construction workers. Approximately 8,810 worker-years would be needed during the 9-year construction period. Operation of the MHTGR would require 910 workers with 180 of these badged for radiation detection.

**Transportation.** Interfacility transfers would be made by rail, truck transport, or pipeline as appropriate. Truck service would be needed for intrafacility transport.

**Waste Management.** The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and

disposal facilities. No radioactive waste would be generated during construction.

The facility design considers and incorporates waste minimization and pollution prevention. Activities that generate radioactive and hazardous wastes would be segregated, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations would also be incorporated into the design.

Table A.2.1.2–4 presents the estimated annual spent nuclear fuel and waste volumes from the MHTGR during construction and operation. Solid and liquid waste streams would be routed to the waste management system. Figure A.2.1.2–3 depicts the waste management system at a dry site while figure A.2.1.1–4 illustrates the waste management system for a wet site. Solid wastes would be characterized and segregated into low-level, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

*Spent Nuclear Fuel.* Spent nuclear fuel would not be reprocessed. Following removal from the reactor, spent nuclear fuel would be stored in the spent fuel storage wells in the reactor service building. After a 3-year cooling period, a fuel-handling machine would load spent nuclear fuel elements, one at a time, into a fuel cylinder. The cylinder would be plugged at each end with suitable shielding and filled with helium. After the end plates were welded on, the cylinder would then be leak-tested. The cylinder would be inserted into a dry storage canister. After the canister is filled with seven fuel cylinders, it would be filled with helium, welded shut, and leak-tested. To remove the dry storage canister from the reactor service building, specially designed equipment would be used to grapple the canister and insert it into a truck-mounted transfer cask. At the storage facility, the canister would be placed into a horizontal concrete storage module. The module would include a passive ventilation system for decay heat removal, metal heat shields to protect the strength of the concrete, and temperature monitors and alarms. These modules would be arrayed on slab-on-grade basemats in a rectangular configuration near the reactor service building. The facility design would have sufficient capacity to store the spent nuclear fuel for the life of the facility. The interim management of spent nuclear fuel (pending availability of a geologic repository) would be in accordance with the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement.*

*Transuranic Waste.* The MHTGR would not generate any TRU waste.

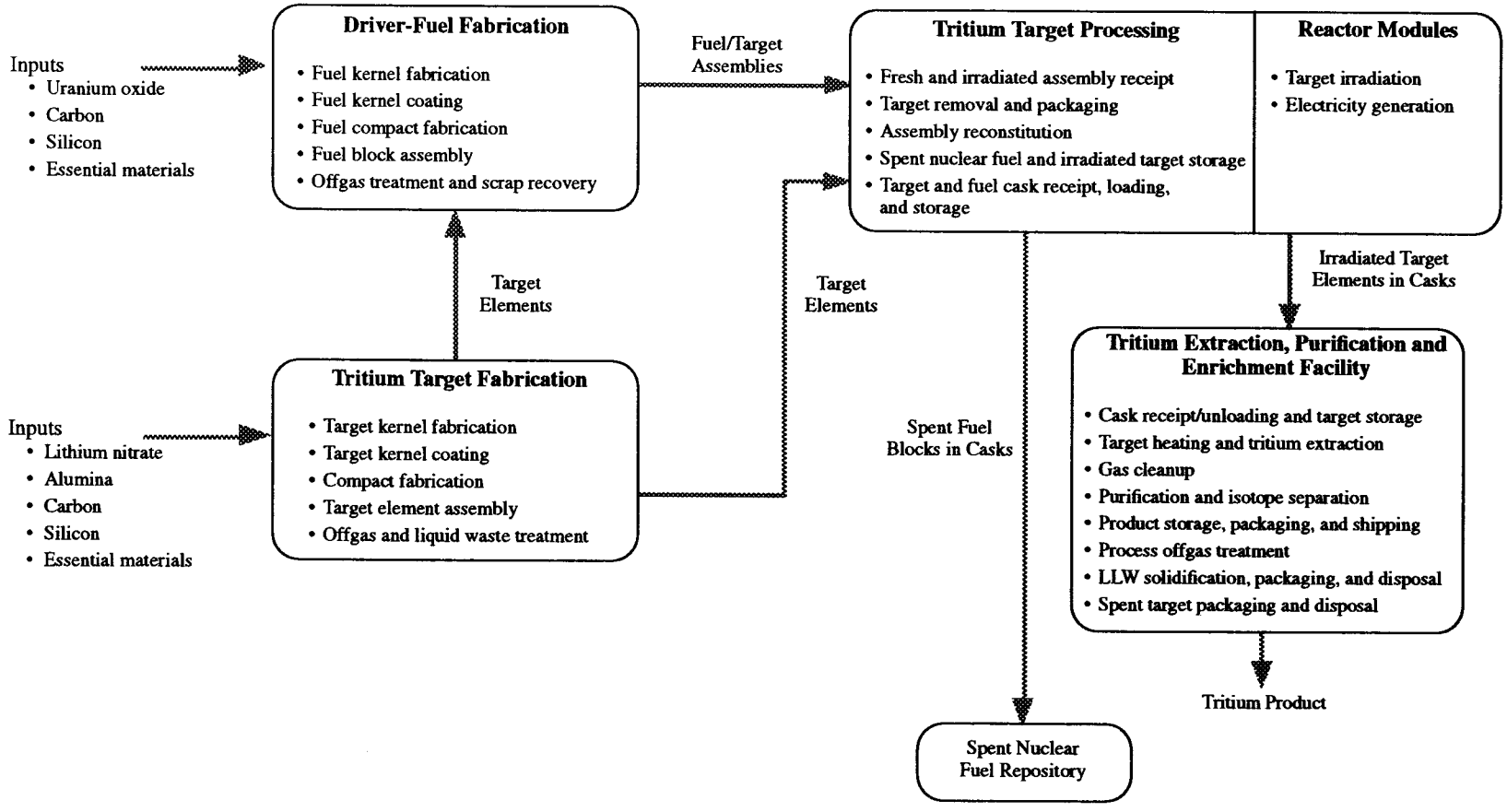
*Low-Level Waste.* LLW would be generated by the operation of the reactor and support facilities. Process effluents would be temporarily stored in storage tanks before treatment into solid LLW that is suitable for LLW disposal. The nonhazardous liquid effluent would then be discharged through a permitted NPDES outfall. The bulk of the solid LLW would be generated in the tritium target processing facility. Solid LLW would consist of contaminated equipment pieces, spent targets, spent uranium beds, plastic sheeting, spent resins, spent HEPA filters, and protective clothing. Solid LLW would be compacted as appropriate and then disposed of in a suitable disposal facility.

*Mixed Low-Level Waste.* No liquid mixed LLW would be generated from the MHTGR. Solid mixed LLW may originate from wipes laden with contaminated oils and hydraulic fluids from the tritium extraction facility. Mixed LLW would be stored in an onsite RCRA-permitted facility until treatment in accordance with the site-specific treatment plan that was developed to comply with the *Federal Facility Compliance Act* of 1992.

*Hazardous Waste.* Liquid hazardous wastes would be generated from cleaning solvents, cutting oils, vacuum pump oils, film processing fluids, hydraulic fluids from mechanical equipment, antifreeze solutions, acids, and paint. The cleaning solvent selected for use would be from a list of nonhalogenated solvents. Liquid hazardous wastes would be collected in DOT-approved containers and sent to a hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters. Solid hazardous wastes would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

*Nonhazardous Waste.* Sewage wastewater would be treated in the sanitary wastewater treatment plant. Sewage wastewater would be kept separate from all industrial and process wastewaters and normally contains no radioactive wastes from the facility. The sewage wastewater would be routinely monitored for radioactive contaminants. The sludge would be disposed of in a permitted sanitary landfill. All treated effluent would be discharged to a stream or river through an NPDES outfall (wet site) or a natural drainage channel (dry site). Cooling tower blowdown would be treated and discharged to the river (wet site). Because the dry site design uses non-evaporative type cooling towers, there would be no liquid discharges resulting from blowdown. The treated effluent from the utility wastewater treatment would be discharged to the river through an NPDES outfall (wet site) or a natural drainage channel. All sludges would be disposed of in a permitted landfill. Other nonrecyclable, solid nonhazardous sanitary and industrial wastes would be compacted and disposed of in a permitted landfill.

The facility design includes stormwater retention facilities with the necessary NPDES monitoring equipment. Rainfall within the Limited Area and Protected Area would be collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge to the natural drainage channels (dry site) or river (wet site). If contaminated, the runoff would be treated in the radioactive waste treatment system. Runoff from the Property Protection Area would be discharged directly into the natural drainage channel or river.




Source: DOE 1992i.

**FIGURE A.2.1.2–1.**—*Modular High Temperature Gas-Cooled Reactor Tritium Production Process.*

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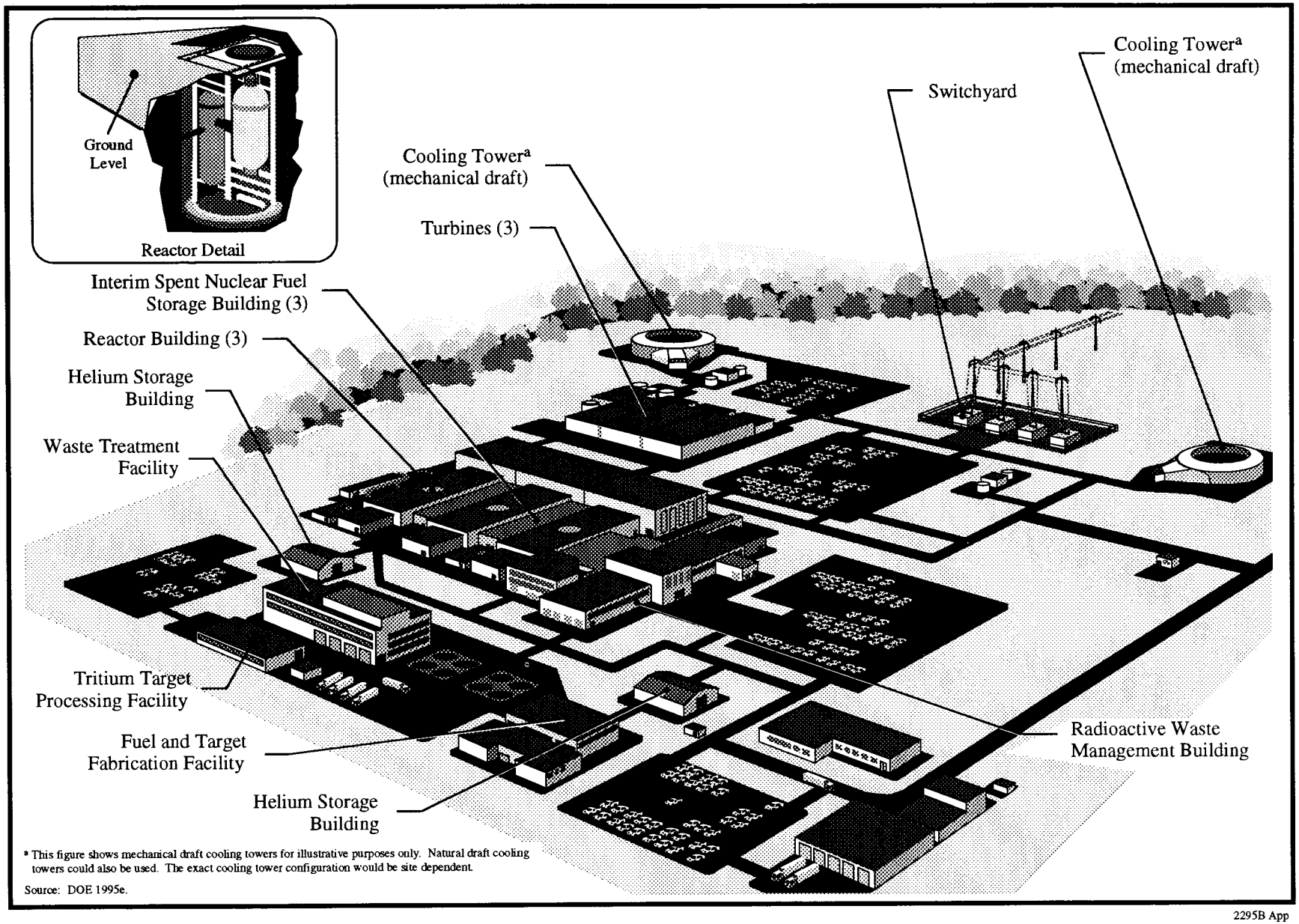


[a] This figure shows mechanical draft cooling towers for illustrative purposes only. Natural draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995e.

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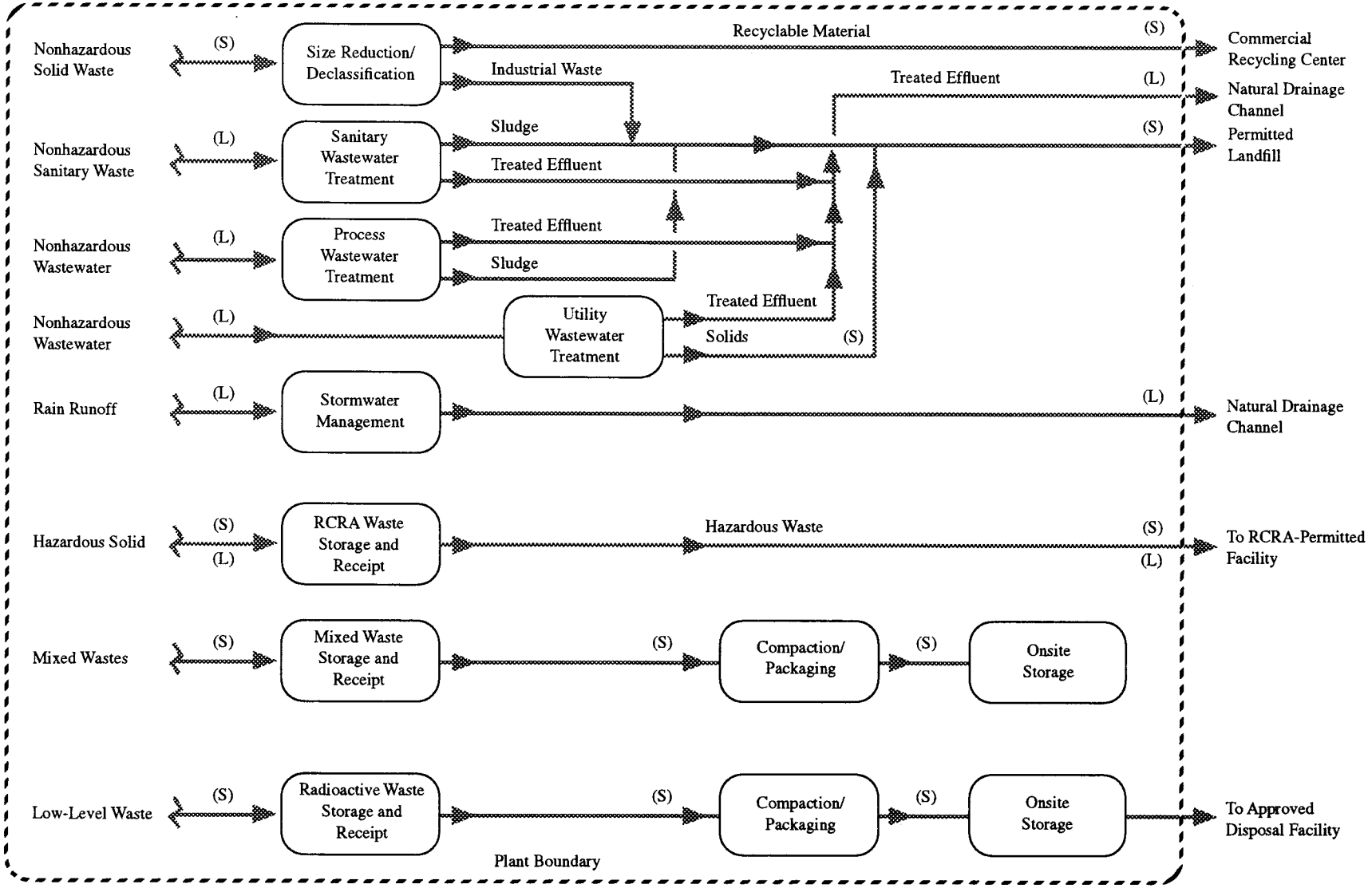
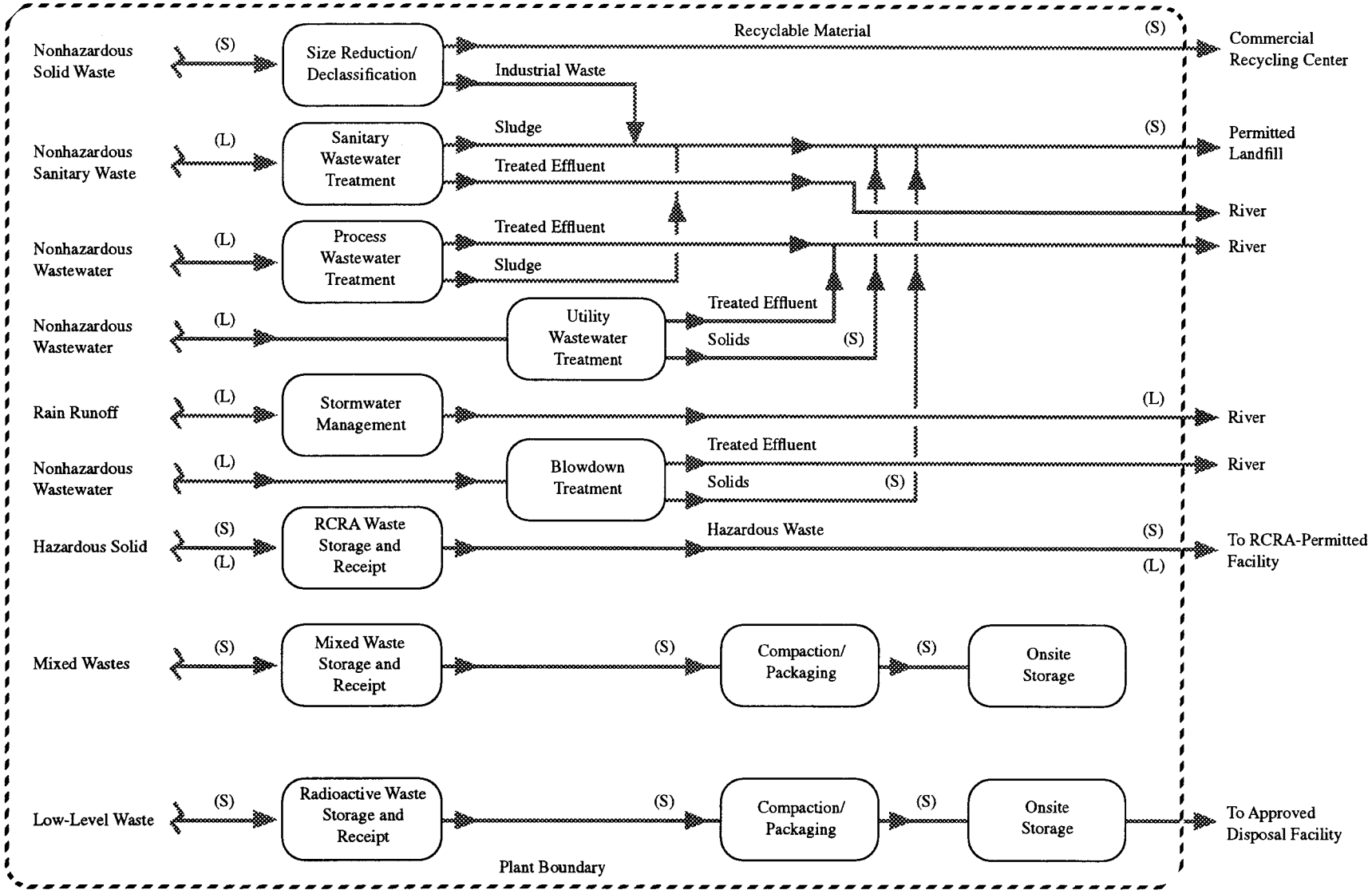
**FIGURE A.2.1.2–2.—*Modular High Temperature Gas-Cooled Reactor Facility (Typical).***




Note: S - solid; L - liquid.
Source: DOE 1994e.

**FIGURE A.2.1.2–3.—*Modular High Temperature Gas-Cooled Reactor Waste Management System (Dry Site).***




Note: S - solid; L - liquid.
Source: DOE 1994e.

**FIGURE A.2.1.2–4.—*Modular High Temperature Gas-Cooled Reactor Waste Management System (Wet Site).***

**TABLE A.2.1.2–1.—*Modular High Temperature Gas-Cooled Reactor Construction Material/Resource Requirements***

| Material/Resource | Consumption |
|---|---|
| Electrical energy (MWh) | 73,000 |
| Concrete ($yd^3$) | 220,000 |
| Steel (tons) | 60,000 |
| Fuel (gal) | 3,200,000 |
| Water (gal) | 160,000,000 |

Source: DOE 1995e.

**TABLE A.2.1.2–2.—*Modular High Temperature Gas-Cooled Reactor Operation Utility Requirements***

| Utility | Consumption |
|---|---|
| **Electrical Energy (MWh per year)** | |
| Wet site | 260,000 |
| Dry site | 360,000 |
| **Electrical Load (MWe)** | |
| Wet site | 36 |
| Dry site | 46 |
| **Fuel** | |
| Gas ($ft^3$ per year) | 6,000,000 |
| Liquid (GPY) | 81,000 |
| **Water (MGY)** | |
| Wet site | 4,000 |
| Dry site | 30 |

Source: DOE 1995e.

**TABLE A.2.1.2–3.—*Modular High Temperature Gas-Cooled Reactor Annual Chemical Requirements***

| Chemical | Quantity (tons) |
|---|---|
| Aluminum | 2 |
| Uranium metal | 1.1 |
| Lithium metal | 1.4 |
| Stainless steel | 0.08 |
| Nitric acid | 49 |
| Sodium hydroxide | 1.1 |
| Sulfuric acid | 0 |

Source: DOE 1995e.

TABLE A.2.1.2–4.—*Modular High Temperature Gas-Cooled Reactor Estimated Spent Nuclear Fuel and Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Dry Site: Annual Volume Generated From Operations ($yd^3$) | Dry Site: Annual Volume Effluent From Operations ($yd^3$) | Wet Site: Annual Volume Generated From Operations ($yd^3$) | Wet Site: Annual Volume Effluent From Operations ($yd^3$) |
|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | 80 | 80 | 80 | 80 |
| **Low-Level** | | | | | |
| Liquid | None | 2,600[a] (525,000 gal) | None | 2,600[a] (525,000) | None |
| Solid | None | 1,300 | 468[b] | 1,300 | 468[b] |
| **Mixed Low-Level** | | | | | |
| Liquid | None | None | None | None | None |
| Solid | None | <1 | <1 | <1 | <1 |
| **Hazardous** | | | | | |
| Liquid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid |
| Solid | 20 | 100 | 100 | 100 | 100 |
| **Nonhazardous (Sanitary)** | | | | | |
| Liquid | 64,400 (13,000,000 gal) | 149,000 (30,000,000 gal) | 149,000 (30,000,000 gal) | 8,070,000 (1,630,000,000 gal) | 8,070,000 (1,630,000,000 gal) |
| Solid | 7,100 | 7,400 | 2,470[c] | 7,400 | 2,470[c] |
| **Nonhazardous (Other)** | | | | | |
| Liquid | 3,020[d] (610,000 gal) | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 6,400[e] | None | 6,400[e] | None |

[a] Liquid LLW is treated with the remaining LLW sludge being solidified.

[b] Assumes a 100:1 wastewater/sludge ratio in the treatment of liquid LLW, followed by 2:1 increase in volume from solidification of sludge. Assumes compaction factor of 3:1 for compactible solids.

[c] Assumes overall compaction factor of 3:1.

[d] Does not include groundwater dewatering, if required.

[e] Recyclable wastes.

Source: DOE 1995e.

### A.2.1.3 *Advanced Light Water Reactor*

**Mission.** The primary mission of the ALWR facility would be to provide the full range of tritium supply functions performed by DOE, as well as waste treatment functions related to ALWR operations.

**Assumptions.** The assumptions used in the design of this facility are listed in section A.2.

**General Functions and Layout.** The ALWR would produce tritium by bombarding an isotope of the element lithium with neutrons produced by nuclear fission reactions in uranium. The interaction of neutrons with lithium creates an unstable lithium isotope that decays almost instantaneously to tritium and an alpha particle. Two ALWR design approaches, based on rated power (large and small reactor, designated Large ALWR and Small ALWR in the following discussion), are under consideration. For either design, the ALWR facility would consist of the following major components: the reactor, tritium target processing, interim spent fuel storage, power conversion, and waste treatment. Figure A.2.1.3–1 depicts the ALWR tritium production process, while figure A.2.1.3–2 shows a typical ALWR facility site plan.

There are two Large ALWR designs under consideration: the approximately 1,300-MWe large pressurized water reactor and the approximately 1,100-MWe large boiling water reactor. Two 600-MWe Small ALWR design concepts are also under consideration: a small pressurized water reactor and a small boiling water reactor.

**Component Facility Functions.**

*Reactor.* The reactor would be an improved version of existing commercial electric power generating reactors and would operate at or near rated power. An ALWR would use ordinary (light) water as both the moderator and coolant. Modifications to the design for tritium production would be minimal, with the principal modification being the replacement of a fraction of the fuel rods by target rods. The enrichment of the remaining fuel rods would be increased to compensate for the missing fuel rods, but derating of core power might be necessary. The core, contained within a steel pressure vessel, would be composed of bundles of fuel and target rods. The fuel rods would consist of tubes of zircaloy cladding filled with uranium dioxide fuel pellets, while the target rods would consist of steel clad lithium aluminate. Target rods would be removed from the core and replaced with new target rods once a year. Both fuel and target rods would be obtained from offsite sources.

The heat dissipation system selected, wet or dry, would depend on site characteristics. Both wet and dry cooling systems would use water as the heat exchange medium. Wet systems would use water towers and the evaporation process to carry off heat. Dry systems, designed for cold climates, would use water in closed nonevaporative cooling towers, to carry off heat by conduction to the atmosphere through heat exchangers. In moderate climates, fans would be added to the dry cooling towers to move air over the vanes of the heat exchangers. There would be some water loss through evaporation in a dry system, but significantly less than with a wet tower. Dry cooling towers would be used for the reactors at all dry sites. The use of wet cooling towers would be an option only for the power conversion facility and only when the facility would be located at a wet site.

*Tritium Target Processing Facility.* After irradiation and a cooling period, the target rods are processed to remove the tritium. The facility houses the processes, laboratory, and other activities associated with handling irradiated elements and is also designed to control the spread of contamination within the facilities and prevent the uncontrolled release of radioactive material to the environment.

*Interim Spent Nuclear Fuel Storage Facility.* Spent nuclear fuel would be sent to, and stored underwater at the interim spent fuel storage facility.

*Power Conversion Facility.* This facility would contain a turbine generator, electrical equipment, control equipment, auxiliary systems, plant support systems, and other equipment.

*Waste Treatment Facility.* This facility would receive all solid, liquid, and gaseous radioactive waste for storage, treatment, and packaging for either release or disposal at an appropriate permanent waste disposal facility.

**Description of Processes.**

*Tritium Target and Fuel Production.* Target and fuel rod fabrication would be done offsite by commercial sources.

*Tritium Production.* Tritium would be produced within the steel clad lithium aluminate target rods, contained in fuel bundles in the reactor core. After about one year, when sufficient tritium would have collected within the target rods, the target rods would be removed from the reactor and placed in the interim fuel storage pool for approximately 1 month to allow for the decay of short-lived radioactive nuclides to acceptable levels. Target rods would then be sent to the onsite tritium extraction facility.

*Tritium Extraction.* The tritium target rods would be removed from the storage pool and sent to the main hot cell. In the hot cell, the target tubes would be heated in a furnace to drive off the tritium, helium, and hydrogen gases. This gas stream would pass through a diffuser to separate the hydrogen isotopes from the other gases.

**Facility Utilities.** Bounding values for the Large ALWR and the Small ALWR facility construction and operation utility requirements are shown in tables A.2.1.3–1 and A.2.1.3–2, respectively.

**Chemicals Required.** Table A.2.1.3–1 depicts chemical resources required during operation.

**Personnel Requirements.** Construction of the ALWR would have a peak employment of 3,500 construction workers for a Large ALWR and 2,200 workers for a Small ALWR. Approximately 12,600 worker years would be needed for a Large ALWR and 7,100 worker years for a Small ALWR during the 6-year construction period. Operation of the Large ALWR would require 830 workers of which 210 would be badged. The Small ALWR would require 500 workers of which 125 would be badged.

**Transportation.** Interfacility transfers would be made by rail, truck transport, or pipeline, as appropriate. Truck service would be needed for intrafacility transport.

**Waste Management.** The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous wastes would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The facility design considers and incorporates waste minimization and pollution prevention. Activities that generate radioactive and hazardous wastes would be segregated, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations would also be incorporated into the design.

Tables A.2.1.3–4 and A.2.1.3–5 present the estimated annual spent nuclear fuel and waste volumes from the ALWR, Large and Small, respectively, during construction and operation. Solid and liquid waste streams would be routed to the waste management system. Figure A.2.1.3–3 depicts the waste management system at a dry site while figure A.2.1.3–4 illustrates the waste management system for a wet site. Solid wastes would be characterized and segregated into LLW, hazardous, and mixed wastes, then treated into a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to

reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

*Spent Nuclear Fuel.* Spent nuclear fuel would not be reprocessed. Fuel elements containing spent nuclear fuel would be stored for up to three years in water-cooled storage basins. The spent nuclear fuel pool would be equipped with an underwater canister loading system. Twelve spent nuclear fuel assemblies would be placed in fixed positions in a borated aluminum or stainless-steel basket for criticality safety. The basket would be contained in a canister whose lids would be seal-welded in place. After the 3-year cooling period, the canisters would be drained, vacuum dried, and backfilled with helium through lid penetrations in preparation for dry storage. The canisters would be transferred in a cask to the interim spent nuclear fuel storage facility. At the storage facility the canisters would be transferred into the final storage cask which would be made of precast concrete and would hold one canister each. Casks would be placed on a concrete basemat. Periodic visual inspections of the canisters and the cask vents would be required. Periodic testing for helium leaks might also be required. The facility design would have sufficient capacity to store the spent nuclear fuel for the life of the facility. The interim management of spent nuclear fuel (pending the availability of a geologic repository) would be in accordance with the ROD from the *DOE Programmatic Spent Nuclear Fuel Management and the Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement.*

*Transuranic Waste.* The ALWR would not generate any TRU waste.

*Low-Level Waste.* LLW would be generated by the operation of the reactor and support facilities. Process effluents would be temporarily stored in storage tanks before treatment into solid LLW that is suitable for disposal. The nonhazardous liquid effluent would then be discharged through a permitted NPDES outfall. The bulk of the solid LLW would then be generated in the reactor and tritium target processing facilities. Solid LLW would consist of contaminated equipment pieces, plastic sheeting, spent targets, spent uranium beds, and protective clothing. It would be compacted as appropriate and then disposed of in a suitable disposal facility.

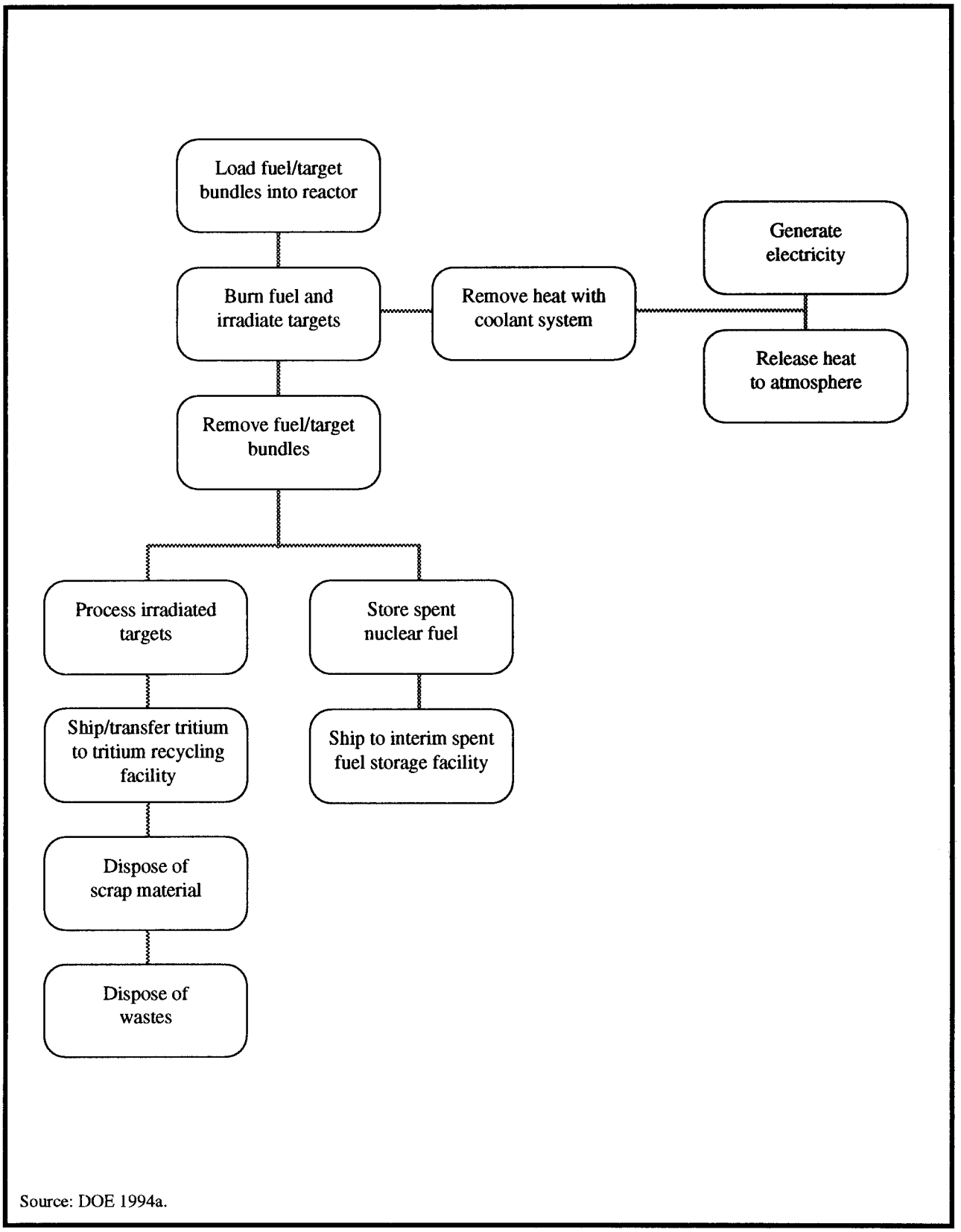
*Mixed Low-Level Waste.* No liquid mixed LLW would be generated from operating the ALWR. Solid mixed LLW may originate from wipes laden with contaminated oils and hydraulic fluids from the tritium extraction facility. Mixed LLW would be stored in an onsite RCRA-permitted storage facility until treatment in accordance with the site-specific treatment plan that was developed to comply with the *Federal Facility Compliance Act* of 1992.

*Hazardous Waste.* Liquid hazardous wastes would be generated from cleaning solvents, cutting oils, vacuum pump oils, film processing fluids, hydraulic fluids from mechanical equipment, antifreeze solutions, acids, and paint. The cleaning solvent selected for use would be from a list of nonhalogenated solvents. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters. Solid hazardous wastes would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

*Nonhazardous Waste.* Sewage wastewater would be treated in the sanitary wastewater treatment plant. Sewage wastewater would be kept separate from all industrial and process wastewaters and normally contains no radioactive wastes from the facility. The sewage wastewater would be routinely monitored for radioactive contaminants. The sewage process sludge would be disposed of in a permitted landfill. All treated effluent would be discharged to a stream or river through an NPDES outfall (wet site) or a natural drainage channel (dry site). Cooling tower blowdown would be treated and discharged to the river (wet site). Because the dry site design uses non-

evaporative-type cooling towers, there are no liquid discharges resulting from blowdown. The treated effluent from the utility wastewater treatment would be discharged to the river through an NPDES outfall (wet site) or a natural drainage channel (dry site). All sludges would be disposed of in a permitted landfill. Other nonrecyclable, solid nonhazardous sanitary and industrial waste would be compacted and disposed of in a permitted landfill.

The facility design includes stormwater retention ponds with the necessary NPDES monitoring equipment. Rainfall within the Limited Area and Protected Area would be collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge to the natural drainage channels (dry site) or river (wet site). If the runoff is contaminated, it would be treated in the radioactive waste treatment system. Runoff from the Property Protection Area would be discharged directly into the natural drainage channels or river.




Source: DOE 1994a.

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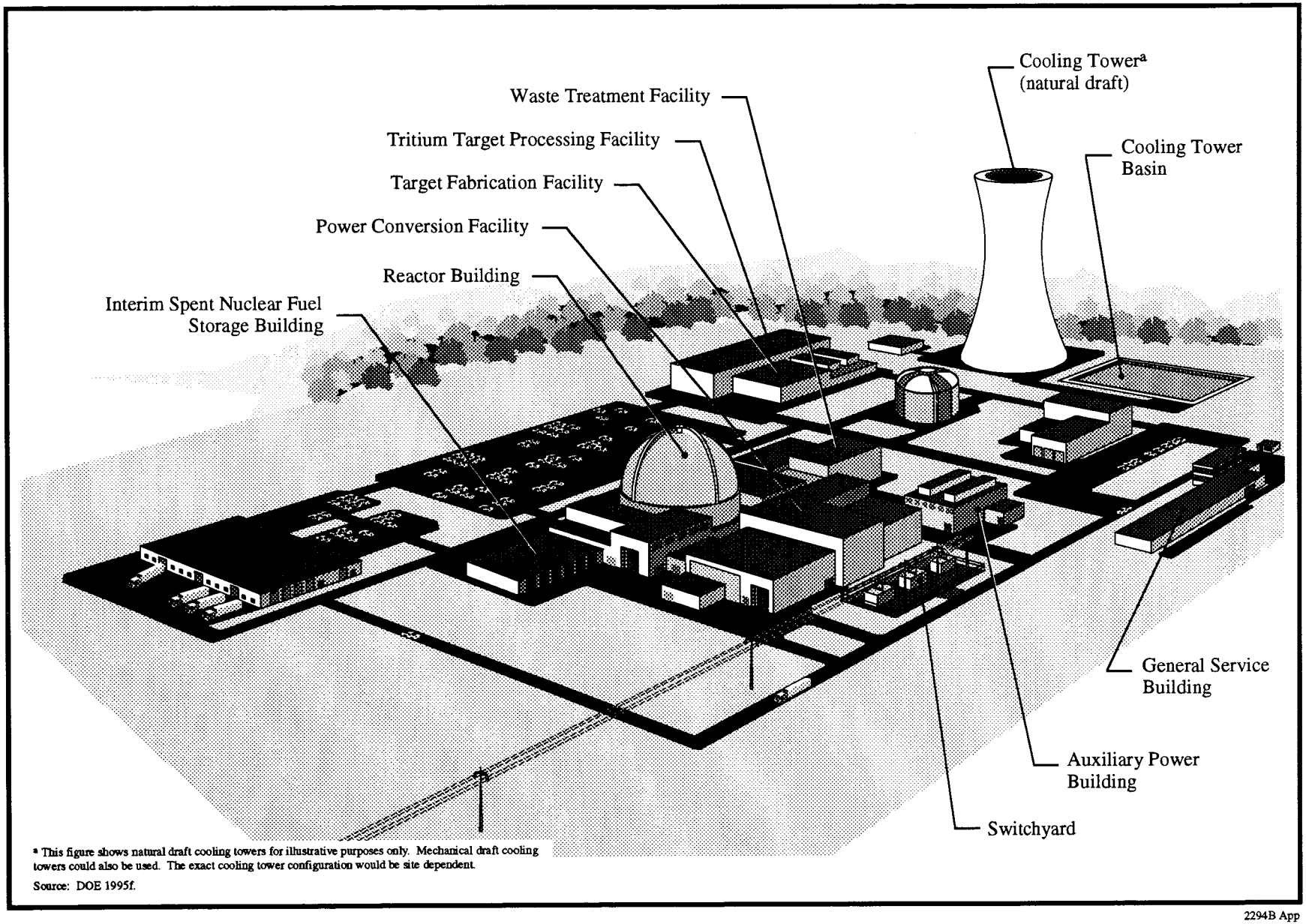
**FIGURE A.2.1.3–1.—*Advanced Light Water Reactor Tritium Production Process.***




[a] This figure shows natural draft cooling towers for illustrative purposes only. Mechanical draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995f.

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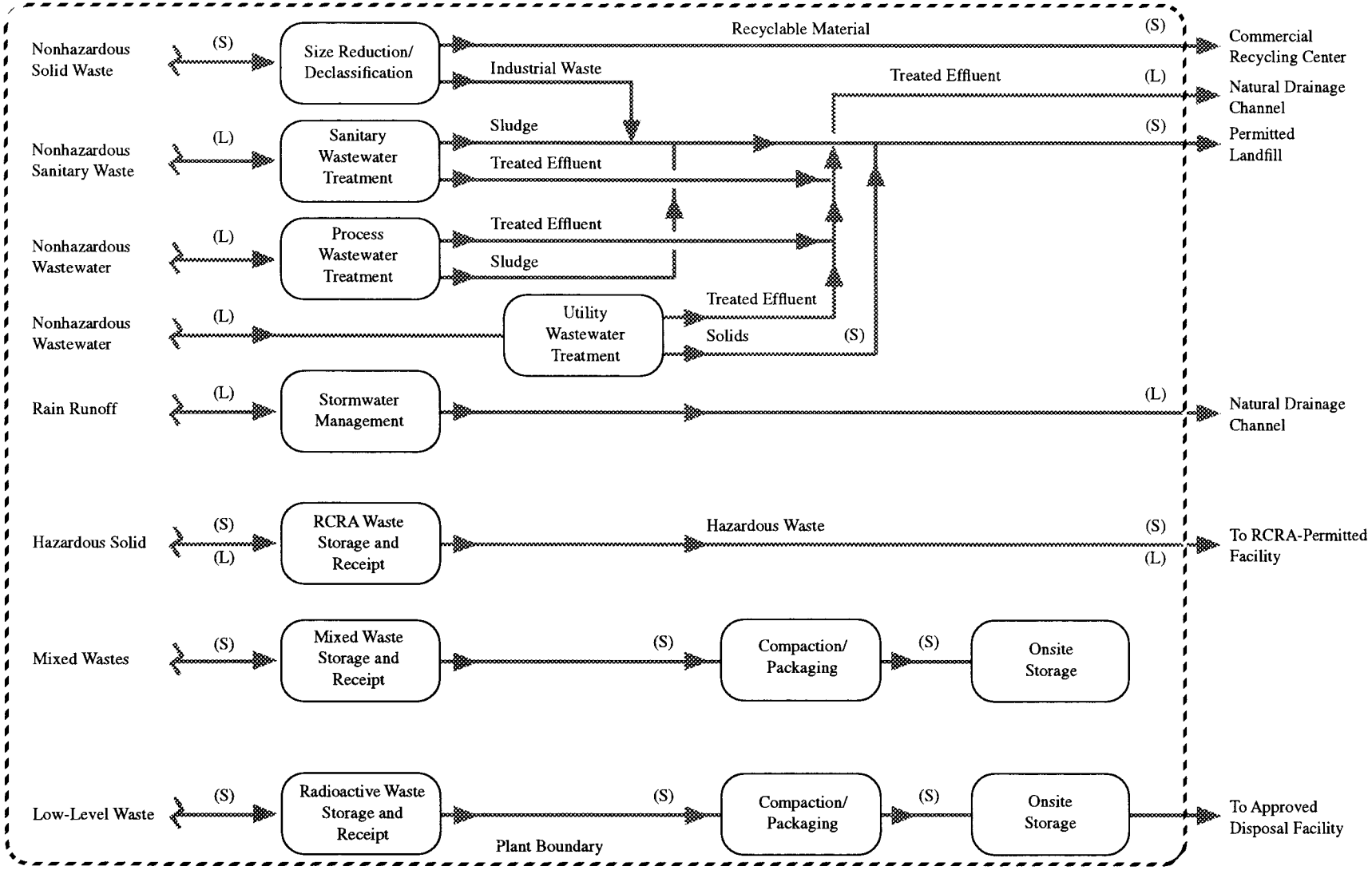
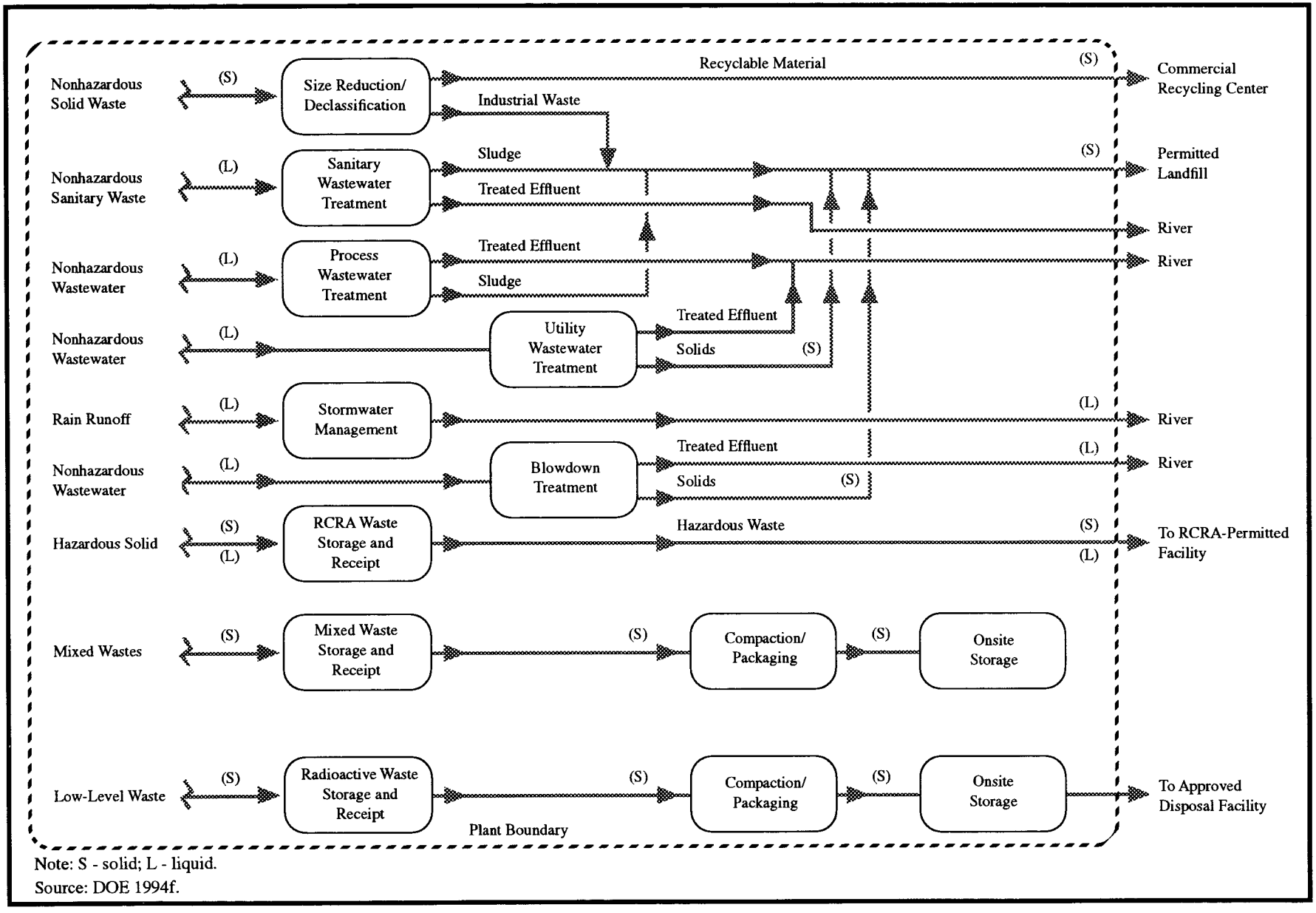
**FIGURE A.2.1.3–2.—*Advanced Light Water Reactor Facility (Typical).***




Note: S - solid; L - liquid.
Source: DOE 1994f.

**FIGURE A.2.1.3–3.**—*Advanced Light Water Reactor Waste Management System (Dry Site).*




Note: S - solid; L - liquid.
Source: DOE 1994f.

**FIGURE A.2.1.3–4.—*Advanced Light Water Reactor Waste Management System (Wet Site).***

**TABLE A.2.1.3–1.—*Advanced Light Water Reactor Construction Material/Resource Requirements***

| | Consumption | |
|---|---|---|
| | ALWR | |
| **Material/ Resource** | **Large** | **Small** |
| Electrical energy (MWh) | 120,000 | 120,000 |
| Concrete ($yd^3$) | 380,000 | 200,000 |
| Steel (tons) | 68,000 | 50,000 |
| Fuel (gal) | 1,500,000 | 1,500,000 |
| Water (gal) | 200,000,000 | 120,000,000 |

Source: DOE 1995f.

**TABLE A.2.1.3–2.—*Advanced Light Water Reactor Operation Utility Requirements***

| | Consumption | |
|---|---|---|
| | ALWR | |
| **Utility** | **Large** | **Small** |
| **Electrical Energy (MWh/yr)** | | |
| Wet site | 700,000 | 380,000 |
| Dry site | 1,100,000 | 580,000 |
| **Electrical Load (MWe)** | | |
| Wet site | 96 | 52 |
| Dry site | 140 | 75 |
| **Fuel** | | |
| Gas ($ft^3$/yr) | 0 | 0 |
| Liquid (GPY) | 200,000 | 110,000 |
| **Water (MGY)** | | |
| Wet site | 16,000 | 7,200 |
| Dry site | 90 | 50 |

Source: DOE 1995f.

**TABLE A.2.1.3–3.—*Advanced Light Water Reactor Annual Chemical Requirements***

| | Quantity (tons) | |
|---|---|---|
| | ALWR | |
| **Chemical** | **Large** | **Small** |
| Aluminum | 1.75 | 0.95 |
| Uranium metal | 0 | 0 |
| Lithium metal | 1.3 | 0.7 |
| Stainless steel | 8.5 | 4.65 |
| Nitric acid | 1,050 | 600 |
| Sodium hydroxide | 0 | 0 |
| Sulfuric acid | 0 | 0 |

Source: DOE 1995f.

TABLE A.2.1.3–4.—*Advanced Light Water Reactor (Large) Estimated Spent Nuclear Fuel and Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Dry Site: Annual Volume Generated From Operations ($yd^3$) | Dry Site: Annual Volume Effluent From Operations ($yd^3$) | Wet Site: Annual Volume Generated From Operations ($yd^3$) | Wet Site: Annual Volume Effluent From Operations ($yd^3$) |
|---|---|---|---|---|---|
| **Spent Nuclear Fuel** | None | 30 | 30 | 30 | 30 |
| **Low-Level** | | | | | |
| Liquid | None | 24,800[a] (5,000,000 gal) | None | 24,800[a] (5,000,000 gal) | None |
| Solid | None | 710 | 567[b] | 710 | 567[b] |
| **Mixed Low-Level** | | | | | |
| Liquid | None | None | None | None | None |
| Solid | None | 6 | 6 | 6 | 6 |
| **Hazardous** | | | | | |
| Liquid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid |
| Solid | 930 | 35 | 35 | 35 | 35 |
| **Nonhazardous (Sanitary)** | | | | | |
| Liquid | 134,000 (27,000,000 gal) | 446,000 (90,000,000 gal) | 446,000 (90,000,000 gal) | 31,100,000 (6,290,000,000 gal) | 31,100,000 (6,290,000,000 gal) |
| Solid | 15,000 | 6,900 | 2,300[c] | 6,900 | 2,300[c] |
| **Nonhazardous (Other)** | | | | | |
| Liquid | 2,480[d] (500,000 gal) | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 5,800[e] | None | 5,800[e] | None |

[a] Liquid LLW is treated with the remaining LLW sludge being solidified.

[b] Assumes a 100:1 wastewater/sludge ratio in the treatment of liquid LLW, followed by 2:1 increase in volume from solidification of sludge. Assumes compaction factor of 3:1 for compactible solids.

[c] Assumes overall compaction factor of 3:1.

[d] Does not include groundwater dewatering, if required.

[e] Recyclable wastes.

Source: DOE 1995f.

**TABLE A.2.1.3–5.—*Advanced Light Water Reactor (Small) Estimated Spent Nuclear Fuel and Waste Volumes***

| | | Dry Site | | Wet Site | |
|---|---|---|---|---|---|
| **Category** | **Annual Average Volume Generated From Construction ($yd^3$)** | **Annual Volume Generated From Operations ($yd^3$)** | **Annual Volume Effluent From Operations ($yd^3$)** | **Annual Volume Generated From Operations ($yd^3$)** | **Annual Volume Effluent From Operations ($yd^3$)** |
| **Spent Nuclear Fuel** | None | 15 | 15 | 15 | 15 |
| **Low-Level** | | | | | |
| Liquid | None | 3,910[a] (790,000 gal) | None | 3,910[a] (790,000 gal) | None |
| Solid | None | 660 | 272[b] | 660 | 272[b] |
| **Mixed Low-Level** | | | | | |
| Liquid | None | None | None | None | None |
| Solid | None | 6 | 6 | 6 | 6 |
| **Hazardous** | | | | | |
| Liquid | Included in solid | Included in solid | Included in solid | Included in solid | Included in solid |
| Solid | 850 | 35 | 35 | 35 | 35 |
| **Nonhazardous (Sanitary)** | | | | | |
| Liquid | 74,300 (15,000,000 gal) | 248,000 (50,000,000 gal) | 248,000 (50,000,000 gal) | 14,100,000 (2,850,000,000 gal) | 14,100,000 (2,850,000,000 gal) |
| Solid | 10,000 | 4,200 | 1,400[c] | 4,200 | 1,400[c] |
| **Nonhazardous (Other)** | | | | | |
| Liquid | 2,480[d] (500,000 gal) | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 3,500[e] | None | 3,500[e] | None |

[a] Liquid LLW is treated with the remaining LLW sludge being solidified.

[b] Assumes a 100:1 wastewater/sludge ratio in the treatment of liquid LLW, followed by 2:1 increase in volume from solidification of sludge. Assumes compaction factor of 3:1 for compactible solids.

[c] Assumes overall compaction factor of 3:1.

[d] Does not include groundwater dewatering, if required.

[e] Recyclable wastes.

Source: DOE 1995f.

### A.2.1.4 *Accelerator Production of Tritium*

**Mission.** The primary mission of the APT facility would be to provide the tritium supply functions performed by DOE, as well as waste treatment functions related to APT operations.

**Assumptions.** The assumptions used in the design of this facility are listed in section A.2.

**General Functions and Layout.** APT would use a high-intensity beam of energetic protons produced by a linear accelerator to strike a heavy metal target. The interaction of the protons with the target material would generate a shower of neutrons which would be absorbed by surrounding helium-3 or lithium-6 atoms to produce tritium. The APT construction approach would be to build it in two phases with the first phase able to provide the steady-state tritium requirement and the second phase able to provide the baseline requirement. There are two different target designs (helium-3 and spallation-induced lithium conversion) under consideration for the baseline case which would each be based on a centrally located spallation neutron source (high Z material). If a phased approach is adopted then the helium-3 target would be the primary choice for the first phase with the spallation-induced lithium conversion target development continuing as backup.

The APT facility would consist of the following components: linear accelerator, beam transport and switchyard, beam stop, target area, secondary cooling, electric substations, emergency power, support, waste treatment, radioactive waste processing, and new target inspection and storage. Figure A.2.1.4–1 is a functional diagram of the APT facility, with the difference between phases noted, while figure A.2.1.4–2 depicts the APT facility site layout.

**Component Facility Functions.**

*Linear Accelerator.* The linear accelerator would consist of a sequence of electromagnetically resonant cavities sustaining radio frequency electric fields that deliver energy to a continuous stream of proton bunches. The initial phase of the APT would use 300 megahertz radio frequency energy in the low energy region and 700 megahertz radio frequency energy in the high energy region to deliver 100 milliamperes of 1 billion electron volt protons to the target chamber. The full-size APT would add another injector leg and a funnel to combine its proton beam with the other to deliver 200 milliamperes of 1 billion electron volt protons (or equivalent beam power at lower energies) to the target chamber.

*Beam Transport and Switchyard.* At the end of the accelerator, the beam would be deflected to one of two target/blanket assemblies or a full power beam stop in the target area by a beam transport and switchyard. This system would consist of bending and focusing magnets and evacuated pipes through which the proton beam would travel. The system would also provide the correct expanded beam size and shape at the target, and switch the beam between target/blanket assemblies as required. Before the beam is directed onto the target, the beam would be sent to the full power beam stop to tune the accelerator.

*Beam Stop.* The beam stop is a device that would be used to stop the proton beam during accelerator tune-up, or to dump the beam when necessary to divert the beam from the target area without shutting down the accelerator. The beam stop would accept the full power beam for an unlimited time while passively radiating the deposited power to an actively cooled structure.

*Target Area.* The target area concepts under consideration are detailed in the description of processes section. The target chamber would be located in a subterranean structure to place the target at the same elevation as the accelerator beam line. A confinement system would envelop the target area and those spaces housing the primary cooling loop components, as well as the compartments in which spent target handling, disassembly, and preparation for shipment are conducted. Tritium extraction would be dependent on the target system selected and is also discussed in the description of processes section.

*Secondary Cooling Facility.* The secondary cooling facility would include cooling towers or cooling ponds for rejecting accelerator waste heat to the atmosphere. The major heat sources would include radio frequency power losses in the accelerator structure, heat produced in power supplies and klystrons, heat deposited in the target/blanket assembly by the proton beam, decay heat from the irradiated target, and heat produced in tritium extraction and target processing facilities.

*Electric Substations.* The electric substations would receive electric power from the commercial grid, convert it to the required voltages for various functions, and distribute it to the accelerator, target/blanket chamber, processing systems, and other onsite facilities.

*Emergency Power.* The emergency power facility would house diesel generators or gas turbines that would be used to provide short-term emergency power to support safety-related loads in the event of temporary failure of the offsite power supply.

*Support Facilities.* The administration facility would house administrative, technical support, and clerical staff. It would include staff offices, a cafeteria, medical facilities, data processing, and a records center. The operations and utilities facility would provide for operational control and monitoring of the accelerator, target/blanket assembly, tritium extraction (as required by the target design), and associated support and safety systems. It would also provide for operator training, including simulators, serve as the center for site safeguards and security, provide personnel monitoring and access control, and house the safety related batteries providing an uninterruptible power supply for critical subsystems. The maintenance facility would provide shop and service areas for maintaining all accelerator, target/blanket, and processing system components. It would also provide warehousing and materials handling for consumables and spare parts for these systems.

*Waste Treatment Facility.* The waste treatment facility would receive and treat all site-generated sanitary sewage for release to the environment in accordance with an NPDES permit.

*Radioactive Waste Processing Facility.* This facility would receive all solid, liquid, and gaseous radioactive waste for storage, treatment, and packaging for either release or disposal at an appropriate permanent waste disposal facility.

*Water Treatment Facility.* This facility would treat water to meet the required quality for the various plant cooling systems. The fire protection system would tap off the facility water supply upstream of the water treatment facility.

*New Target Inspection and Storage Facility.* This facility would provide for the unloading, receipt, inspection and storage of new target/blanket assemblies fabricated offsite. The facility would also load packaged spent targets onto transport equipment for removal to the final disposal site.

**Description of Processes.**

*Accelerator Operation.* The accelerator would operate in continuous wave mode, meaning that the cavities would be excited 100 percent of the time rather than part of the time as in a pulsed system. Several types of accelerating structure geometries would be used to couple radio frequency energy to the beam over different velocity ranges. At full energy, the protons would travel at approximately 0.9 times the speed of light. The radio frequency field in the accelerating structures would be generated by a series of 1 megawatt (MW) klystrons (high power electron tubes) distributed along the length of the accelerator. For most of its 0.75 mile length, the accelerator would be located in a sealed, concrete-lined tunnel buried under about 40 feet of earth. A similar length building on the surface would house the klystrons, power supplies, and controls.

The magnetic transport system would direct the proton beam from the end of the accelerator to the tritium production target/blanket assembly. When the beam is directed to one of the target assemblies, the other would be undergoing service or would be on standby. When the beam is not directed at a target, it would be directed to the full-power beam stop through the diagnostic beam channel used for tuning the accelerator. At the ends of the transport channels, the beam would be expanded to a large, rectangular, uniform current distribution form to match the power density requirements of the targets.

Multiple redundant sensors distributed throughout the accelerator and beam lines would act within extremely short time frames to determine if the beam were out of acceptable limits in terms of position, energy, size, intensity distribution, etc. Malfunctions or out of tolerance values for any of these devices would terminate the beam.

Heat transport loops would be needed for the target blanket system. The primary cooling loop would transport the heat generated in the target and blanket (separate cooling loops) to a secondary cooling loop. The secondary cooling loop would transfer heat through a heat exchanger system to the atmosphere.

*Tritium Production.* The APT tritium production process would be dependent on the choice of APT design and target assembly employed. Two target concepts currently under consideration for the full-size APT are: helium-3 and spallation-induced lithium conversion.

- Helium-3—The target chamber would house a low-pressure, low-temperature target/blanket assembly consisting of a water-cooled inconel beam entrance window followed by a neutron-producing target of tungsten as depicted in figure A.2.1.4–3. That target would be cooled by circulating heavy water moderator with circulating, contained helium-3. The assembly would have lead in a surrounding annular region to provide neutron multiplication and moderation. About 60 percent of the tritium would be produced in the blanket region of the system; the remainder would be produced in a separate helium-3 volume in the spallation target. The purpose of the second helium-3 gas region is to act as a decoupler to reduce absorption of neutrons back into the tungsten source region. Tritium would be continuously removed from both regions by taking a side stream of the circulating helium-3 gas into a nearby processing area.

- Spallation-Induced Lithium Conversion—The target area, depicted in figure A.2.1.4–4 would contain a target system consisting of a heavy water-cooled lead spallation target, and light water-cooled lithium-aluminum target separated from the accelerator by a beam entrance window. The assembly would operate at relatively low temperature and low pressure. High energy protons would induce spallation of the lead target, thereby generating neutrons. Heavy water coolant would remove the heat of spallation and moderate the neutrons to thermal energy. The lithium-6 isotope within the light water-cooled lithium-aluminum target rods would capture the thermal neutrons and produce tritium.

*Tritium Extraction.* The extraction process would be dependent on the APT design and target concept employed.

- Helium-3—In this process, a small slipstream would be taken off the gas circulating through the heavy water source and blanket regions, and hydrogen and tritium would be extracted using a permeable membrane technique. The helium-3 would then be recirculated to the target area. The extracted hydrogen and tritium would be separated by cryogenic distillation. The tritium would be of very high purity. An area would be required for cooling and radiation shielding of spent tungsten removed from the target cavity. Remote handling apparatus would load packaged targets into shipping casks and onto rail or truck vehicles. Spent tungsten targets would go to existing waste management facilities for final disposal. The estimated volume of this material is small, typically on the order of a few cubic meters per year of operation. Figure A.2.1.4–5 provides the flow diagram for the helium-3 process.

- Spallation-Induced Lithium Conversion—Following irradiation, the targets would be removed and transported to the disassembly basin, where the target tubes would be allowed to cool for approximately 6 months so that short-lived isotopes could decay. After cooling, the target tubes would be washed within the shielded transport cask, placed in a crucible, inserted into a furnace, and heated to drive off the gases, including the tritium product. The gas stream from the furnace, mainly helium and hydrogen isotopes, including tritium, would pass through a diffusing process to separate the hydrogen isotopes from helium and

other impurities. This process would cycle the gas between two beds of treated diatomaceous earth used as a filter aid. One bed would be heated to drive off the gases; the other bed would be cooled to promote gas absorption. Figure A.2.1.4–6 depicts the flow diagram for the spallation-induced lithium conversion process.

**Facility Utilities.** Facility construction and operation utility requirements are shown in tables A.2.1.4–1 and A.2.1.4–2, respectively.

**Chemicals Required.** Table A.2.1.4–3 depicts chemical resources required during operations.

**Personnel Requirements.** Construction of the APT would have a peak employment of 1,350 construction workers. Approximately 3,440 worker years would be needed during the 5-year construction period. In the phased approach, the majority of civil engineering construction for both phases would be completed during initial construction. The upgrade from the first phase to the Full APT would involve installation of the equipment in the second injection line, the funnel, and additional radio frequency power systems. Operation of either APT facility would require 624 workers with 258 of these badged for radiation detection.

**Transportation.** Interfacility transfers would be made by rail or truck transport. Truck service would be needed for intrafacility movements. Helium would be received in bulk by rail and unloaded into cylinders for storage.

**Waste Management.** Solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The facility design incorporates waste minimization and pollution prevention. Activities that generate radioactive and hazardous wastes would be segregated, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Tables A.2.1.4–4 and A.2.1.4–5 present the estimated annual waste volumes from the Full APT facility for the two target designs during construction and operation. Table A.2.1.4–4 presents the estimated waste volumes for the Phased APT. All process and waste systems would be housed in enclosures designed to contain and allow recovery of tritium leaks. A gaseous waste system would recover residual tritium before releasing the waste to the atmosphere. Solid and liquid waste streams would be routed to the waste management system. Solid wastes would then be characterized and segregated into LLW, hazardous, and mixed wastes, then treated into a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

*Spent Nuclear Fuel.* The APT facility would not generate any spent nuclear fuel.

*Transuranic Waste.* The APT facility would not generate any TRU waste.

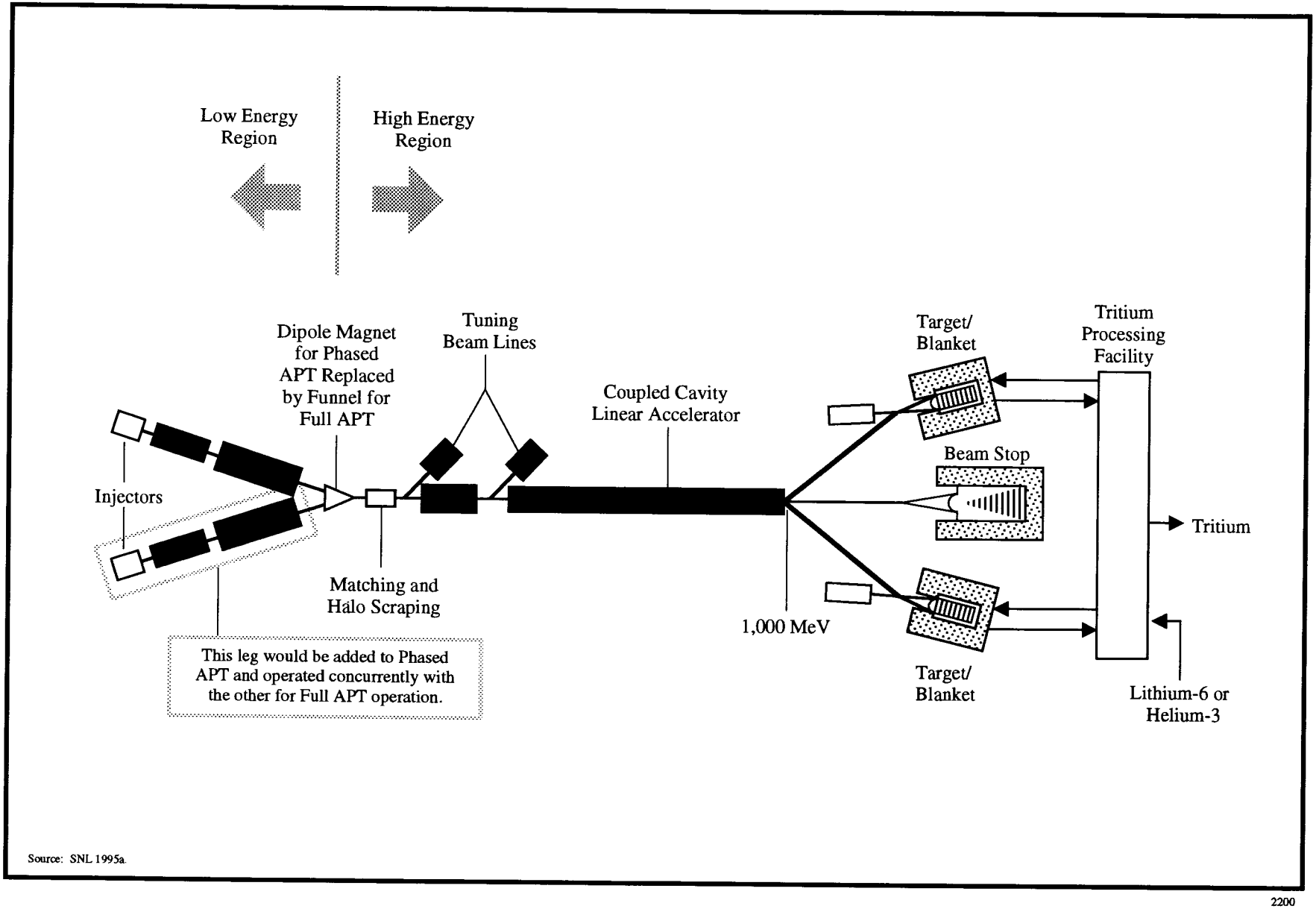
*Low-Level Waste.* LLW would be generated by operations in the target and blanket area and the target tritium-extraction facility. The process stripper would remove any tritium from process streams; thus eliminating liquid LLW generation. The bulk of the solid LLW would be generated in the tritium extraction facility. Solid LLW from the accelerator would result from klystron and ion pump refurbishment and cooling system maintenance. LLW generated in the spallation-induced lithium conversion (or lithium-aluminum) target area would include treatment residues, spent resin filters, piping and pressure tubes, the window, and job control wastes. From the helium-3 target area solid LLW would include treatment residues, spent resins and filters, inconel, zircaloy, and job control wastes. The lithium-aluminum target tritium-extraction system would generate job control wastes, crucibles, spent lithium-aluminum melts, piping, valves, and filters. Solid LLW from the helium-3 target tritium extraction system would include job control wastes, piping, valves, and filters. Solid LLW would be compacted as appropriate and then disposed of in a suitable disposal facility.

*Mixed Low-Level Waste.* No liquid mixed LLW would be generated from the APT facility. Solid mixed LLW from the accelerator would include solvent rags and discarded batteries. The lithium-aluminum target area would generate solvent rags, lead aluminum targets, discarded batteries, and paint while the tritium target extraction facility sources of mixed LLW would include contaminated batteries, aerosol cans, and spent solvents. After removal from the target area, the spent lead targets would be stored in pools for one year. In this time the activity would decrease from 10 to 20 million curies (Ci) to 100,000 Ci. The targets would then be processed for disposal as solid mixed LLW. Mixed LLW from the helium-3 target area would include discarded batteries and paint with the tritium target extraction facility generating contaminated batteries, aerosol cans, and spent solvents. Mixed waste would be processed in accordance with the site-specific treatment plan that was developed to comply with the *Federal Facility Compliance Act* of 1992.

*Hazardous Waste.* Depending on the treatment technology selected, a small quantity (< 1 gal) of liquid hazardous wastes could be generated from the treatment of mixed LLW. Solid hazardous wastes would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to an onsite hazardous waste storage facility for staging prior to shipment to a commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

*Nonhazardous Waste.* Sewage wastewater would be treated in the waste treatment facility. Sewage wastewater would be kept separate from all industrial and process wastewaters and would normally contain no radioactive wastes from the facility. The sewage wastewater would be routinely monitored for radioactive contaminates. The sludge and other nonrecyclable solid sanitary and industrial wastes would be disposed of in a permitted landfill. The treated effluent would be discharged to the river through an NPDES outfall (wet site) or a natural drainage channel (dry site). Cooling tower blowdown would be treated and discharged to the river (wet site) or recycled for reuse (dry site). The treated effluent from the utility wastewater treatment would be discharged to the river through an NPDES outfall (wet site) or a natural drainage channel (dry site). All sludges would be disposed of in a permitted landfill.

The facility design includes stormwater retention facilities with the necessary NPDES monitoring equipment. Rainfall is collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge to the natural drainage channels (dry site) or river (wet site). If the runoff were contaminated, it would be treated in the radioactive waste treatment system. Runoff outside the facility area would be discharged directly into the natural drainage channels or river.




Source: SNL 1995a.

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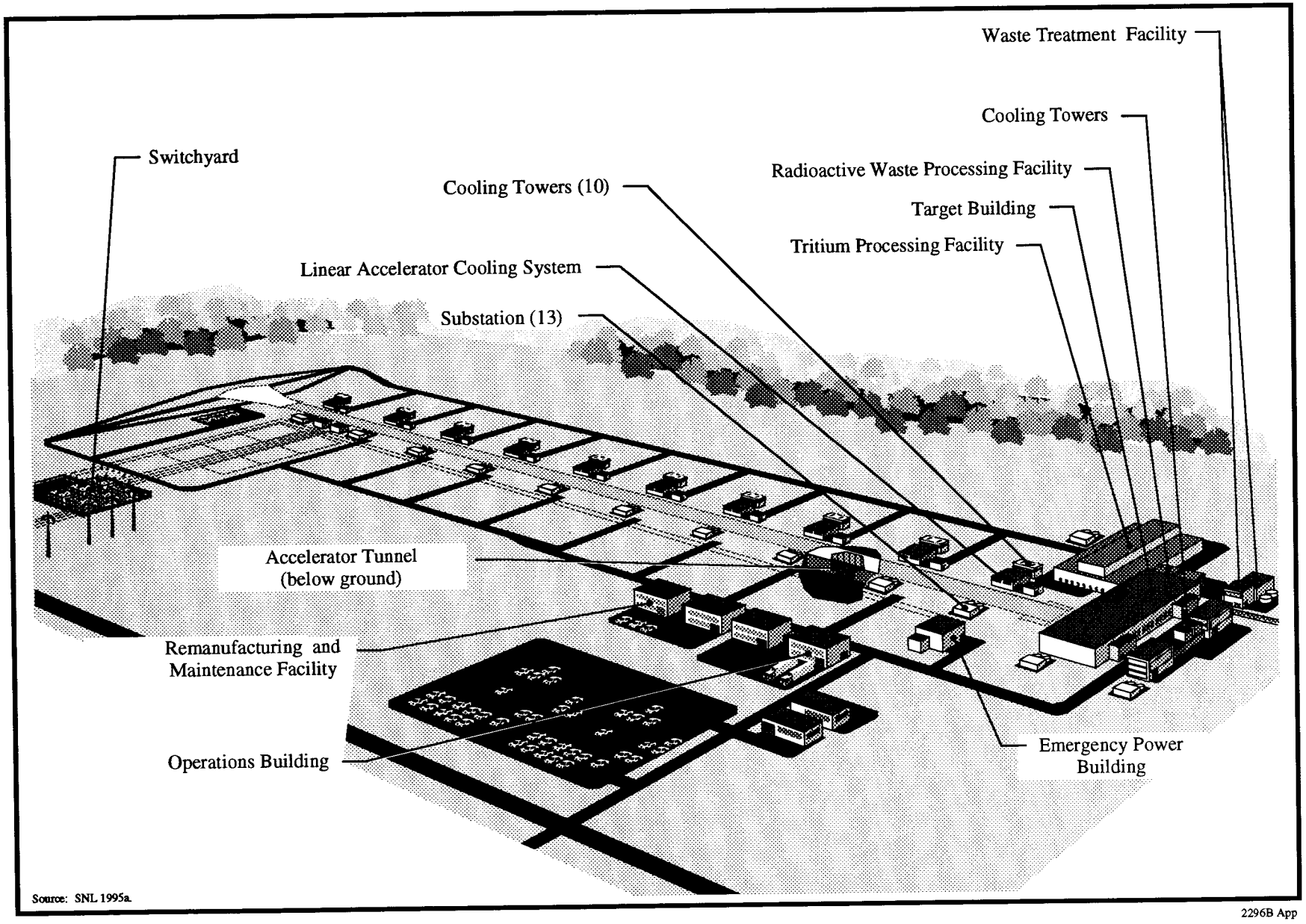
**FIGURE A.2.1.4–1.—*Accelerator Production of Tritium Facility Functional Layout.***




Source: SNL 1995a.

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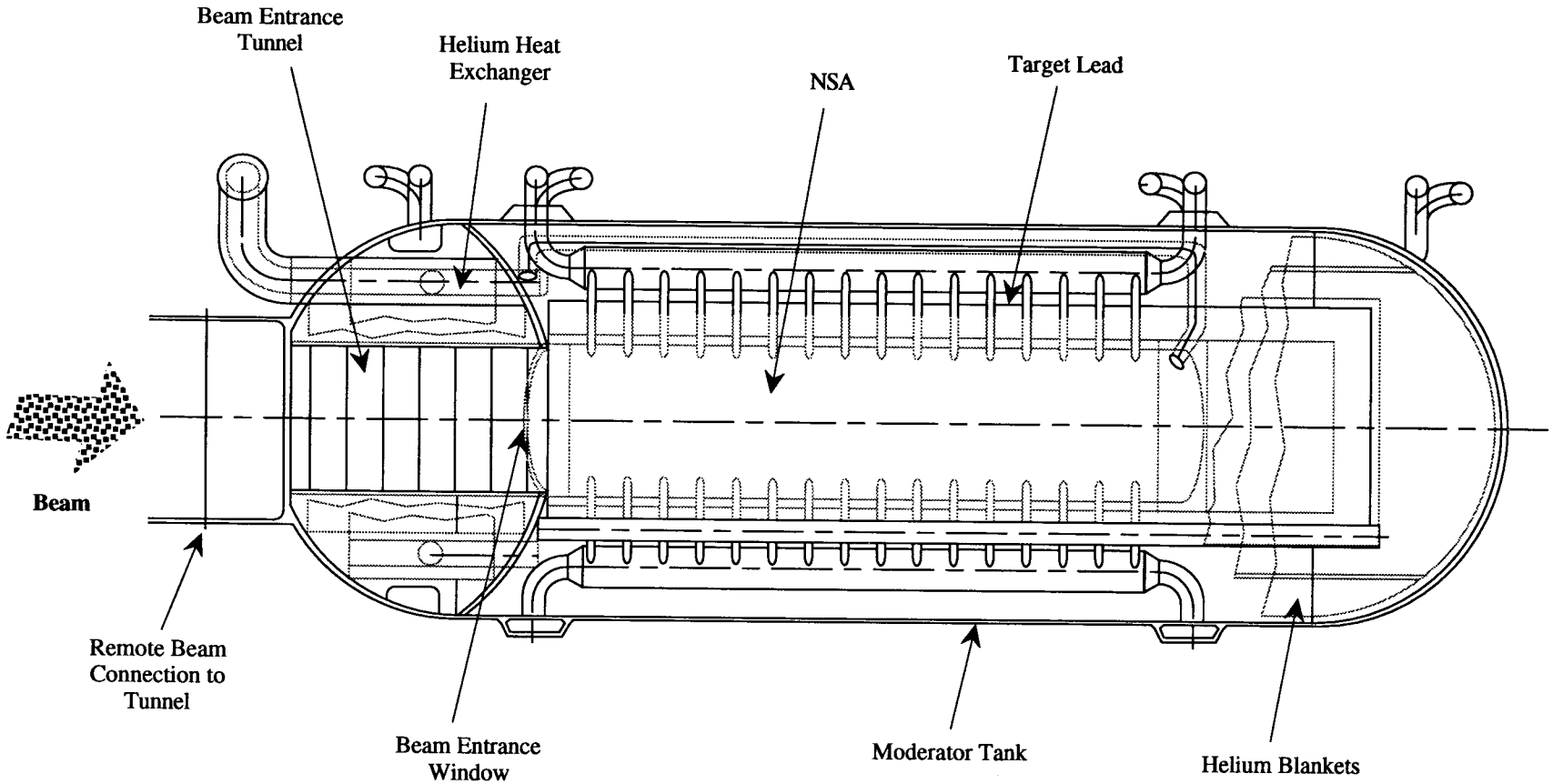
**FIGURE A.2.1.4–2.—*Accelerator Production of Tritium Facility Site Layout (Typical).***




Source: SNL 1993a.

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**FIGURE A.2.1.4–3.—*Accelerator Production of Tritium/Helium-3 Target System.***

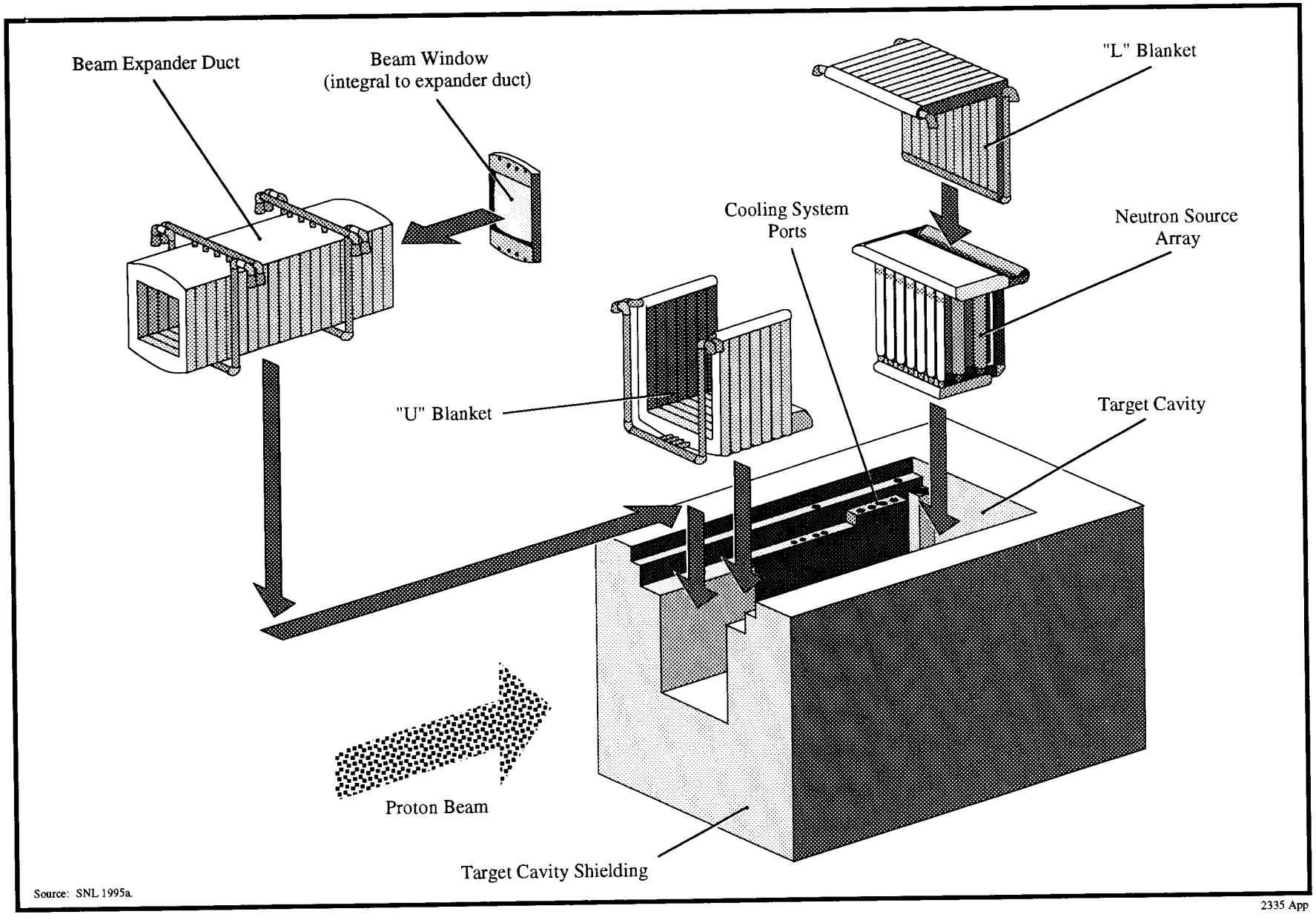
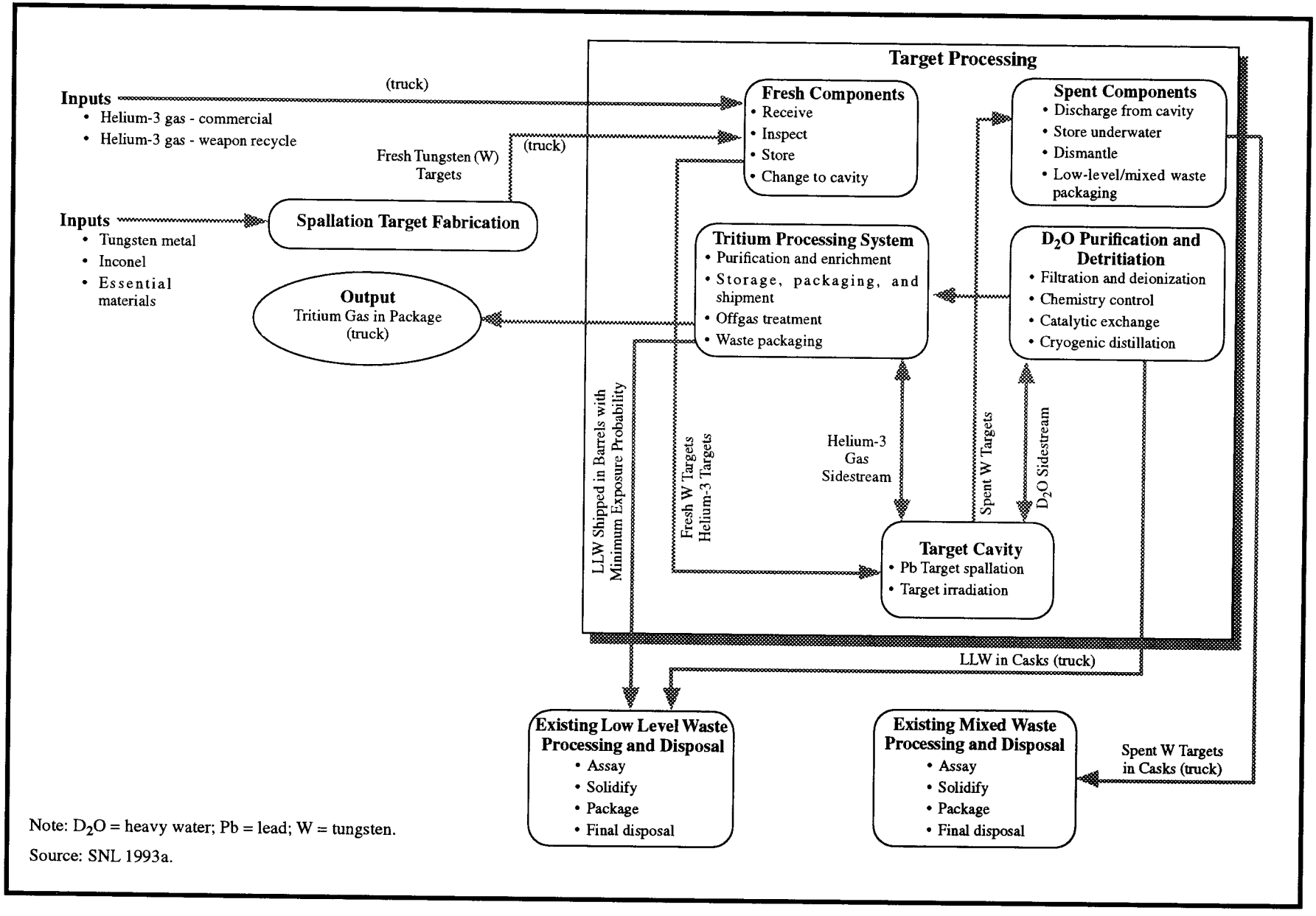



**FIGURE A.2.1.4–4.**—*Accelerator Production of Tritium/Spallation-Induced Lithium Conversion Target System (Exploded).*




Note: $D_2O$ = heavy water; Pb = lead; W = tungsten.

Source: SNL 1993a.

**FIGURE A.2.1.4–5.**—*Flow Diagram for Accelerator Production of Tritium/Helium-3 Target.*

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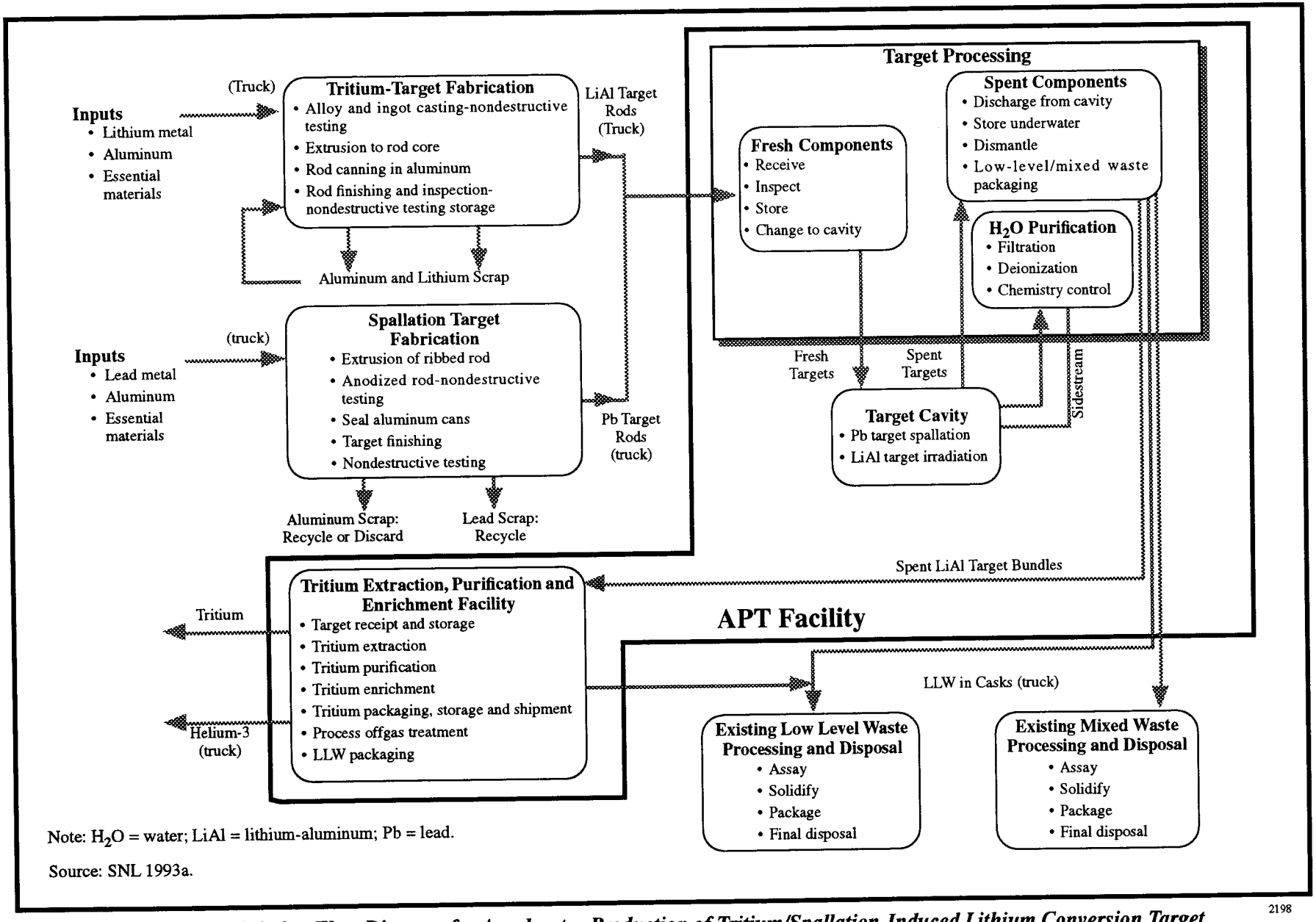



Note: $H_2O$ = water; LiAl = lithium-aluminum; Pb = lead.

Source: SNL 1993a.

**FIGURE A.2.1.4–6.**—*Flow Diagram for Accelerator Production of Tritium/Spallation-Induced Lithium Conversion Target.*

**TABLE A.2.1.4–1.—*Accelerator Production of Tritium Construction Material/Resource Requirements***

| Material/ Resource | Consumption APT Full | Consumption APT Phased |
|---|---|---|
| Electrical Energy (MWh) | 40,000 | 40,000 |
| Concrete ($yd^3$) | 275,000 | 275,000 |
| Steel (tons) | 61,495 | 55,820 |
| Fuel (gal) | 2,110,000 | 2,110,000 |
| Water (gal) | 41,700,000 | 41,700,000 |

Source: SNL 1995a.

**TABLE A.2.1.4–2.—*Accelerator Production of Tritium Operation Utility Requirements***

| Utility | Consumption APT Full | Consumption APT Phased |
|---|---|---|
| **Electrical Energy (MWh/yr)** | 3,740,000 | 2,400,000 |
| **Electrical Load (MWe)** | 550 | 355 |
| **Fuel** | | |
| Gas ($ft^3$ per year) | 0 | 0 |
| Liquid (GPY) | 13,200 | 13,200 |
| **Water (MGY)** | 2,642 | 1,691 |

Source: SNL 1995aSNL 1995a.

**TABLE A.2.1.4–3.—*Accelerator Production of Tritium Annual Chemical Requirements***

| Chemical | Quantity (tons) APT Full | Quantity (tons) APT Phased |
|---|---|---|
| Aluminum | 50 | 13.3 |
| Uranium metal | 0.4 | 0 |
| Lithium metal | 1.2 | 0 |
| Stainless steel | 32 | 7.1 |
| Sodium hydroxide | 0.22 | 0.14 |
| Sulfuric acid | 1,375 | 880 |

Source: SNL 1995a.

TABLE A.2.1.4–4.—*Accelerator Production of Tritium (Helium-3 Target) Estimated Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Annual Volume Generated From Operations ($yd^3$) | Annual Volume Effluent From Operations: Dry Site ($yd^3$) | Annual Volume Effluent From Operations: Wet Site ($yd^3$) |
|---|---|---|---|---|
| **Low-Level** | | | | |
| Liquid | None | None | None | None |
| Solid | None | 72 | 57[a] | 57[a] |
| **Mixed Low-Level** | | | | |
| Liquid | None | None | None | None |
| Solid | None | 3.7 | 3.1 | 3.1 |
| **Hazardous** | | | | |
| Liquid | Included in solid | None | 0.0003 (0.06 gal) | 0.0003 (0.06 gal) |
| Solid | 13 | 1.2 | 1.2 | 1.2 |
| **Nonhazardous (Sanitary)** | | | | |
| Liquid | 1,570[b] (317,000 gal) | 1,990,000[c] (401,000,000 gal) | <1,000 (<200,000 gal) | 1,990,000 (401,000,000 gal) |
| Solid | 5,500 | 1,240 | 413[d] | 413[d] |
| **Nonhazardous (Other)** | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None | Included in sanitary | None |

[a] Assumes compaction factor of 3:1 for personnel protection equipment compactible solids and 2:1 for metallics.

[b] Does not include groundwater dewatering, if required.

[c] At a dry site, the treated effluent from cooling tower blowdown and the sanitary wastewater treatment plant are recycled for reuse as cooling water makeup and other services after treatment.

[d] Assumes overall compaction factor of 3:1.

Source: SNL 1995a.

TABLE A.2.1.4–5.—*Accelerator Production of Tritium (Spallation-Induced Lithium Conversion Target) Estimated Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Annual Volume Generated From Operations ($yd^3$) | Annual Volume Effluent From Operations: Dry Site ($yd^3$) | Annual Volume Effluent From Operations: Wet Site ($yd^3$) |
|---|---|---|---|---|
| **Low-Level** | | | | |
| Liquid | None | None | None | None |
| Solid | None | 544 | 221[a] | 221[a] |
| **Mixed Low-Level** | | | | |
| Liquid | None | None | None | None |
| Solid | None | 6.8 | 3.9 | 3.9 |
| **Hazardous** | | | | |
| Liquid | Included in solid | None | 0.003 (0.6 gal) | 0.003 (0.6 gal) |
| Solid | 13 | 2.5 | 2.5 | 2.5 |
| **Nonhazardous (Sanitary)** | | | | |
| Liquid | 1,570[b] (317,000 gal) | 1,990,000[c] (401,000,000 gal) | <1,000 (<200,000 gal) | 1,990,000 (401,000,000 gal) |
| Solid | 5,500 | 1,240 | 413[d] | 413[d] |
| **Nonhazardous (Other)** | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None | Included in sanitary | None |

[a] Assumes compaction factor of 3:1 for personnel protection equipment compactible solids and 2:1 for metallics.

[b] Does not include groundwater dewatering, if required.

[c] At a dry site, the treated effluent from cooling tower blowdown and the sanitary wastewater treatment plant are recycled for reuse as cooling water makeup and other services after treatment.

[d] Assumes overall compaction factor of 3:1.

Source: SNL 1995a.

TABLE A.2.1.4–6.—*Phased Accelerator Production of Tritium (Helium-3 Target Only) Estimated Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Annual Volume Generated From Operations ($yd^3$) | Annual Volume Effluent From Operations: Dry Site ($yd^3$) | Annual Volume Effluent From Operations: Wet Site ($yd^3$) |
|---|---|---|---|---|
| **Low-Level** | | | | |
| Liquid | None | None | None | None |
| Solid | None | 68 | 54[a] | 54[a] |
| **Mixed Low-Level** | | | | |
| Liquid | None | None | None | None |
| Solid | None | 3 | 2.5 | 2.5 |
| **Hazardous** | | | | |
| Liquid | Included in solid | None | 0.0003 (0.06 gal) | 0.0003 (0.06 gal) |
| Solid | 13 | 1.2 | 1.2 | 1.2 |
| **Nonhazardous (Sanitary)** | | | | |
| Liquid | 1,570[b] (317,000 gal) | 1,990,000[c] (401,000,000 gal) | <1,000 (<200,000 gal) | 1,990,000 (401,000,000 gal) |
| Solid | 5,500 | 1,240 | 413[d] | 413[d] |
| **Nonhazardous (Other)** | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | None | Included in sanitary | None |

[a] Assumes compaction factor of 3:1 for personnel protection equipment compactible solids and 2:1 for metallics.

[b] Does not include groundwater dewatering, if required.

[c] At a dry site, the treated effluent from cooling tower blowdown and the sanitary wastewater treatment plant are recycled for reuse as cooling water makeup and other services after treatment.

[d] Assumes overall compaction factor of 3:1.

Source: SNL 1995a.

### A.2.2 Tritium Recycling

Tritium recycling would either be collocated with the tritium supply facility or be located at SRS. If the tritium supply facility is collocated with a new recycling facility, there may be a potential for some efficiencies to be realized through the sharing of common facilities such as sanitary wastewater treatment. However, these efficiencies are not considered large enough to affect either a technology or site selection and thus, are not analyzed in this PEIS. At SRS, an upgrade of the existing recycling facilities would be implemented instead of constructing a new facility. The descriptions of the new recycling facilities, and the upgrades to the existing facilities at SRS, are in the following sections.

#### A.2.2.1 *New Recycling Facility*

**Missions.** The primary mission of the new tritium recycling facility would be to provide the full range of tritium processing, recycling, and packaging functions performed by DOE, as well as associated testing and waste management functions.

**Assumptions.** The assumptions used in the design of this facility are listed in section A.2.

**General Functions and Layout.** The tritium recycling facility would consist of two major buildings and associated support facilities as depicted in figure A.2.2.1–1. The tritium recycling building would house the systems that process inventories of tritium and tritium contaminated items along with the plant operations center.

The auxiliary building, the other major building, would house the non-tritium functions as well as the emergency power diesel generators for the tritium recycling building. The plant support buildings would provide general services such as administration, cafeteria, fire protection, medical, environmental, safety, and health.

**Component Facility Functions.** Many modern nuclear weapons employ tritium gas or a mixture of tritium and deuterium gases, contained in reservoirs, to improve weapons performance. Radioactive decay reduces the reservoir tritium content, which means that stockpile reservoirs must be replaced periodically. The residual tritium from the returned reservoirs would be recovered for recycle, and the empty reservoir would be reclaimed and reused if possible. At the tritium recycling facility, reservoirs would be subjected to stringent environmental and performance tests to ensure their integrity under all service conditions. The facility also would be the source for tritium used for commercial applications and for fusion research and development.

**Description of Processes.** The tritium recycling facility processes are depicted in figure A.2.2.1–2 Tritium would be received in reservoirs returned from the field, or as virgin tritium from an extraction facility associated with a tritium supply facility. The reservoirs would be unpacked from their shipping containers and stored in a vault prior to being emptied.

The reservoirs would be emptied and the contained gases processed to separate the hydrogen isotopes from other gases, primarily helium-3 (a product of the radioactive decay of tritium). The hydrogen isotopes would be separated into tritium, deuterium, and protium (normal hydrogen). Tritium and deuterium would be used to prepare a specified isotopic mixture for the reservoirs. Protium would be discharged to the stack. The empty reservoirs would be reclaimed, if possible, and refilled. Reservoirs that could not be reclaimed would be handled as solid LLW. The helium-3 would be purified to remove any residual tritium and other contaminants prior to packaging as a by-product.

The reclaimed and/or new reservoirs would be filled with specific mixtures of gases. These gas mixtures could be obtained by using recovered gas of the proper specification, adding pure isotopes to the mix of recovered gases, or blending the pure isotopes. Once the reservoirs were filled, they would be sealed with a closure weld, trimmed, surface decontaminated, leak tested, inspected, marked, assayed for tritium content, and fitted with an explosively-actuated squib valve, if required. The reservoirs would then be placed in a storage vault until they were packaged and sent to the field for limited life component exchange in a weapon system.

A sampling of the newly-filled reservoirs would be placed in the life storage area for surveillance operations. As these reservoirs age, they would be examined and tested to confirm predicted behavior

and to ensure the integrity and function of the reservoirs in the field. Surveillance operations would include environmental testing, functional testing, calorimetry, flow testing, and burst testing. These tests would be performed to evaluate the behavior of the selected reservoirs (including reservoirs returned from the field or in life storage) under test conditions. The tritium recycling facility would also provide capabilities for metallurgical studies and gas sample composition analyses. The tritium recycling facility also would have the capability to fill containers with specified gas mixtures for commercial use and research applications.

**Facility Utilities.** Facility construction and operation utility requirements are shown in tables A.2.2.1–1 and A.2.2.1–1, respectively.

**Chemicals Required.** Table A.2.2.1–3 depicts chemical resources required during operation.

**Personnel Requirements.** Construction of the tritium recycling facility would have a peak employment of 335 construction workers. Approximately 992 worker years would be needed during the 4-year construction period. Operation requirements of the tritium recycling facility would be 870 workers total with 400 of these badged for radiation detection.

**Transportation.** Interfacility transfers would be made by DOE contract cargo carriers. Truck service would be needed for intrafacility transport.

**Waste Management.** The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as waste adhesives, oils, and solvent rags would be packaged in DOT approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The facility design considers and incorporates waste minimization and pollution prevention. The facility recovery system would provide the necessary equipment to recover, purify, and package helium-3, and to recover tritium from tritiated wastes generated within the facility, possible offsite sources, and the glove box inert atmospheres. The recovery system consists of strippers, tritiated aqueous recovery, tritium scrap recovery, and helium-3 recovery. Activities that generate radioactive and hazardous wastes would be segregated, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. After evacuating and flushing with argon, empty reservoirs would be reclaimed, if necessary, and refilled. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Tritium recycling operations would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations would also be incorporated into the design.

Table A.2.2.1–4 presents the estimated annual waste volumes from the tritium recycling facility during construction and operation. One can expect a significant reduction in waste generation once the facility is built and operational. Solid and liquid waste streams would be routed to the waste management system. Figure A.2.2.1–3 depicts the waste management system for the tritium recycling facility at a dry site, while figure A.2.2.1–4 illustrates the waste management system for a wet site. Solid wastes would be characterized and segregated into LLW, hazardous, and mixed wastes, then immobilized and packaged for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas during and after a fire would be contained, monitored, sampled, and if required, retained until disposed.

*Spent Nuclear Fuel.* The tritium recycling facility would not generate any spent nuclear fuel.

*Transuranic Waste.* The tritium recycling facility would not generate any TRU waste.

*Low-Level Waste.* Tritium-contaminated wastewater would be generated by hydraulic burst testing and by the strippers. The tritium-contaminated wastewater is treated in the tritium recovery system to recover the tritium. Strippers are designed to remove hydrogen isotopes, water vapor, and methane from the process waste streams and the glove box recirculating inert atmosphere.

Strippers consist of four types (process, primary, secondary, and purge) and would utilize a similar process to recover residual tritium from tritiated gases. The process stripper would be designed to remove hydrogen isotopes and water vapor from process waste streams by oxidizing elemental hydrogen isotopes and trapping the oxides on molecular sieves (Z-beds) prior to discharging to the stack. After the bed becomes saturated, it would be heated with the water vapor then being routed to tritium aqueous recovery to recover hydrogen isotopes.

The primary stripper would be designed to continuously process and recirculate the glove box nitrogen or argon atmosphere in order to maintain acceptable tritium, water vapor, and oxygen levels inside the glove box. The secondary stripper would have the same design as a standby unit to process nitrogen gas from glove boxes when a tritium leak occurs, and also to serve as a spare for the primary stripper. The purge stripper employs the same type of process used in the other strippers to remove hydrogen isotopes and water vapor from the glove box airlock gas prior to discharging to the stack. The purge stripper also processes the blowdown from the primary and secondary strippers.

Two primary tritiated aqueous recovery processes (reactive metal bed and electrolysis) would be utilized in the tritium recycling facility. It has been assumed that the reactive metal bed process would handle the stripper Z-bed tritiated water and the electrolysis process would handle the tritiated water from outside sources. Tritium scrap recovery would take tritiated solid wastes such as metals and pieces from reservoir reclamation, metallography, and burst testing; reduce them in size; and then transfer them to a container which would be baked in a vacuum oven. The tritiated off-gas would be evacuated to a storage tank for accountability of tritium prior to transfer to the process stripper. Any pyrophoric materials would be oxidized to allow for chemical stability. The solid components would then be cooled in the oven and managed in accordance with the solid LLW procedures outlined below.

Solid LLW would consist of hydride beds, U-beds, Z-beds, stripper catalysts, retired process equipment, glove box tools wastes, process metal residues, unreclaimed reservoirs, and low-specific activity waste. The LLW solids are reduced in size, immobilized, stabilized, packaged, and staged in the Long-Term Waste Storage Building while awaiting shipment to a suitable LLW disposal facility.

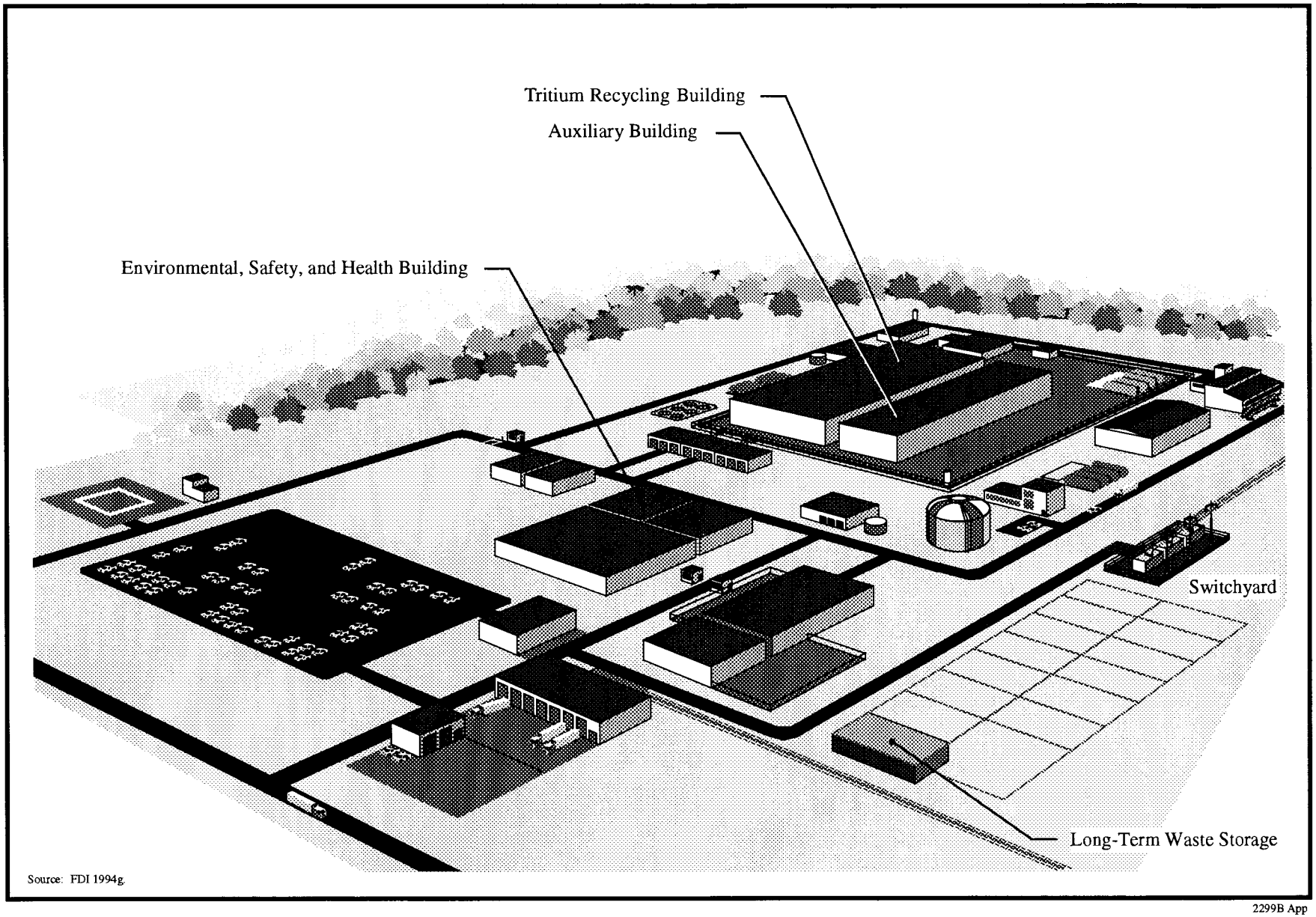
*Mixed Low-Level Waste.* Liquid mixed LLW would originate from potentially-contaminated used compressor and glove box bubblers (sealpot) oil. Solid mixed LLW would include solvent rags and oil-contaminated materials with trace quantities of tritium. Mixed LLW would be stored in the RCRA-permitted Long-Term Storage Building onsite until treatment and disposal in accordance with the site-specific treatment plan that is being developed to comply with the *Federal Facility Compliance Act* of 1992.

*Hazardous Waste.* The cleaning solvents selected would be from a list of nonhalogenated solvents to the extent practicable. Solid hazardous wastes would be generated from nonradioactive materials such as solvent rags, containers with residual hazardous materials, and lead-acid batteries. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to the Waste Management Building for staging prior to shipment to a commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

*Nonhazardous Waste.* Sewage wastewater would be treated in the facility sanitary wastewater treatment facility. Sewage wastewater would be kept separate from all industrial and process wastewaters and normally contains no radioactive wastes from the facility. The sewage wastewater would be routinely

monitored for radioactive contaminants. The sludge would be disposed of in a permitted landfill. As illustrated in figure A.2.2.1–3, at the dry site the treated effluent would be recycled to the cooling tower and used as makeup, while figure A.2.2.1–4 shows the treated effluent at the wet site being discharged into the river through a permitted NPDES outfall. Process wastewater would be treated at the process wastewater treatment facility. The sludge would be disposed of in a permitted sanitary landfill and the water would be reclaimed.

The facility design includes stormwater retention ponds with the necessary NPDES monitoring equipment. Rainfall within the main facility area would be collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge to the natural drainage channels (dry site) or river (wet site). If the runoff were contaminated, it would be treated in the process wastewater treating system. Runoff from the site outside of the main facility area would be discharged directly into the natural drainage channels or river. As depicted in figure A.2.2.1–3, at a dry site, the utility wastewater treatment system collects blowdown from the steam system and tower cooling water system. The blowdown water would be filtered and treated by conventional water treatment methods. The treated effluent serves as makeup to the tower cooling water system. The reject water would be evaporated and the condensate would be used for boiler makeup. The concentrated watery solution would be sent to a spray drier and the dry solids would be disposed of in a permitted landfill. As shown in figure A.2.2.1–4, at a wet site, the blowdown from the cooling tower would be discharged after treatment directly into the river through an NPDES outfall. Solid industrial, clean-shredded metal, after sanitization and demilitarization, and trash are collected and sent to a permitted landfill.




Source: FDI 1994g.

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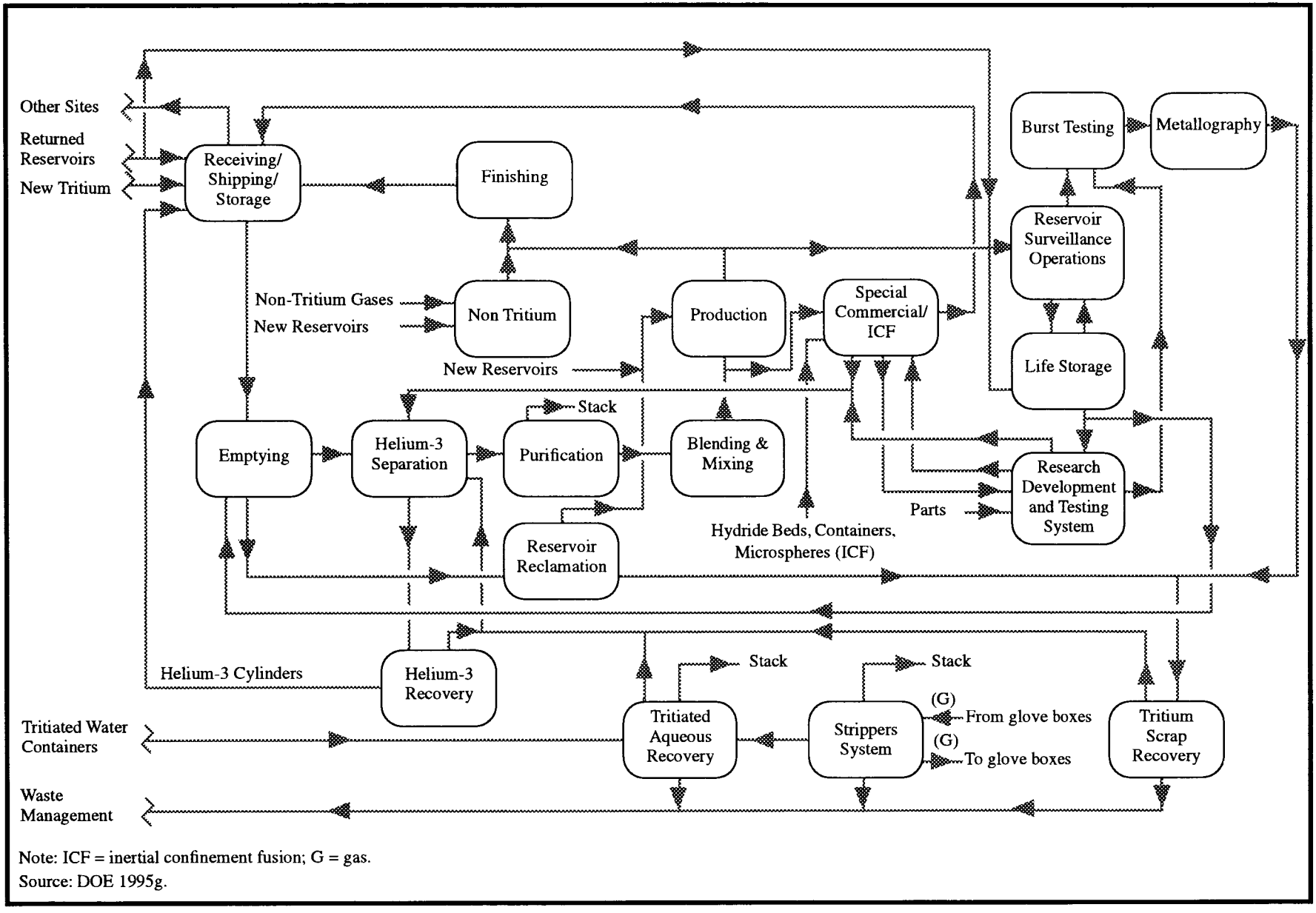
**FIGURE A.2.2.1–1.**—*New Tritium Recycling Facility (Typical).*




Note: ICF = inertial confinement fusion; G = gas.
Source: DOE 1995g.

**FIGURE A.2.2.1–2.—*New Tritium Recycling Facility Processes.***

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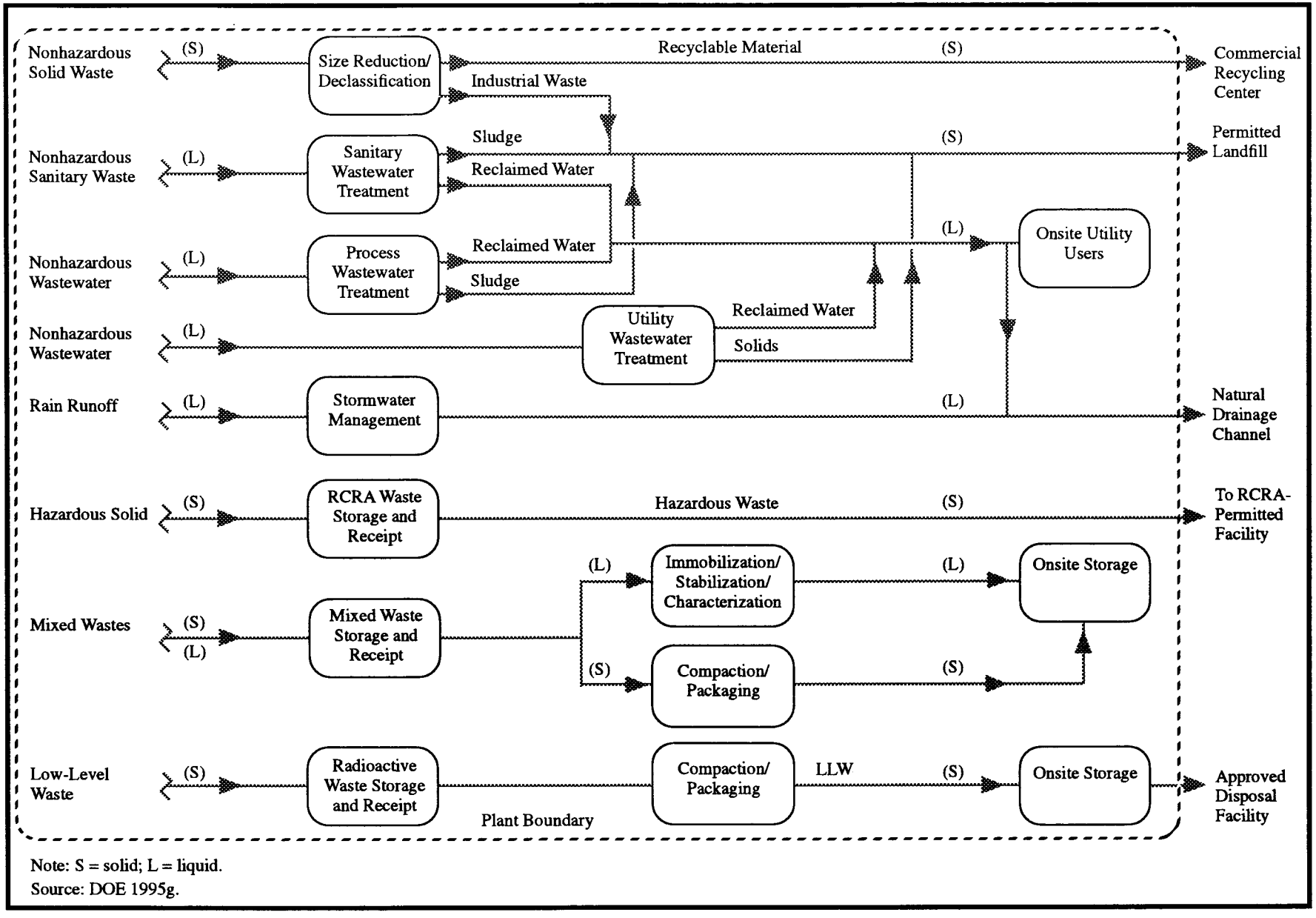
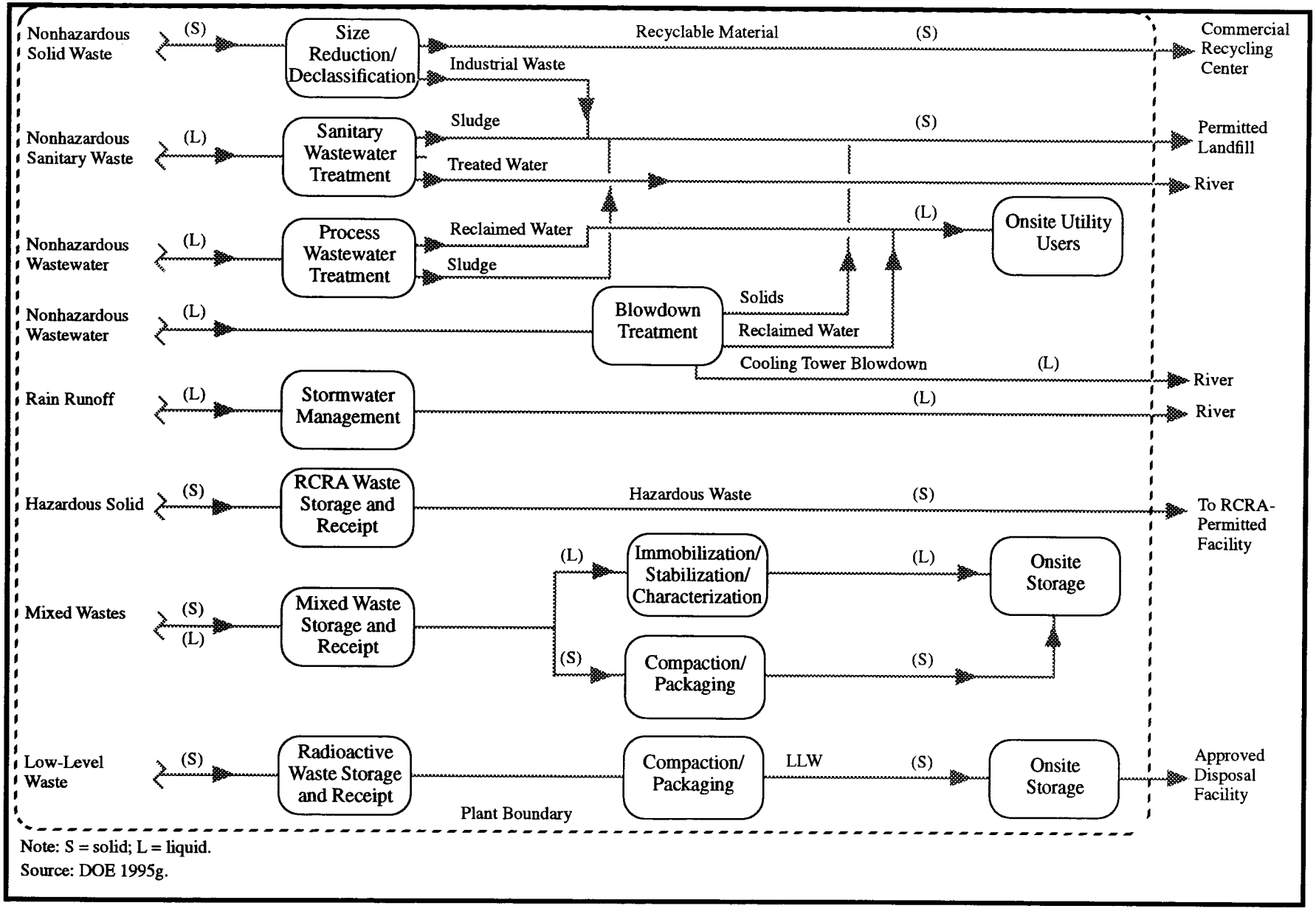



Note: S = solid; L = liquid.
Source: DOE 1995g.

**FIGURE A.2.2.1–3.—*New Tritium Recycling Waste Management System Process (Dry Site).***




Note: S = solid; L = liquid.
Source: DOE 1995g.

**FIGURE A.2.2.1–4.—*New Tritium Recycling Waste Management System Process (Wet Site).***

**TABLE A.2.2.1–1.—*New Tritium Recycling Facility Construction Material/Resource Requirements***

| Material/Resources | Consumption |
|---|---|
| Electrical energy (MWh) | 10,000 |
| Concrete ($yd^3$) | 32,000 |
| Steel (tons) | 5,600 |
| Fuel (gal) | 260,000 |
| Water (gal) | 6,100,000 |

Source: DOE 1995g.

**TABLE A.2.2.1–2.—*New Tritium Recycling Facility Operation Utility Requirements***

| Utility | Consumption |
|---|---|
| **Electrical Energy (MWh/yr)** | 88,000 |
| **Electrical Load, (peak) (MWe)** | 16 |
| **Fuel** | |
| Gas ($ft^3$/yr) | 7,000,000 |
| Liquid (GPY) | 50,000 |
| **Water (MGY)** | |
| Wet site | 37 |
| Dry site | 14 |

Source: DOE 1995g.

**TABLE A.2.2.1–3.—*New Tritium Recycling Facility Annual Chemical Requirements***

| Chemical | Quantity (lb) |
|---|---|
| **Solid** | |
| Adhesives, lubricants, and paints | 360 |
| Catalyst and molecular sieves | 1,200 |
| Depleted uranium (water decomposer) | 2,800 |
| Other[a] | 1,700 |
| **Liquid** | |
| Organic solvents[b] | 3,700 |
| Petroleum oils[c] | 600 |
| Water treatment chemicals[d] | 9,800 |
| Other[e] | 3,700 |
| **Gaseous** | |
| Argon | 190,000 |
| Helium | 500 |
| Nitrogen | 3,500,000 |
| Other[f] | 8,900 |

[a] Includes calcium nitrate, desiccant, magnesium metal, oxalic acid, Q-wax sealing compound, and silica gel.

[b] Includes ethyl alcohol, methanol, refrigerants, paint removers and thinners.

[c] Includes lubricating oils and seal oils.

[d] Includes aluminum sulfate, bentonite, chlorine, diethylaminoethanol, hydrazine, inorganic and organic phosphate, phosphoric acid, polyelectrolyte, polyphosphate, sodium sulfite and sulfuric acid. May be solid, liquid, or gas.

[e] Includes decontamination solutions.

[f] Includes acetylene, hydrogen, deuterium, carbon dioxide, oxygen, methane and methane-argon mixture.

Source: DOE 1995g.

TABLE A.2.2.1–4.—*New Tritium Recycling Facility Estimated Waste Volumes*

| Category | Annual Average Volume Generated From Construction ($yd^3$) | Dry Site: Annual Volume Generated From Operations ($yd^3$) | Dry Site: Annual Volume Effluent From Operations ($yd^3$) | Wet Site: Annual Volume Generated From Operations ($yd^3$) | Wet Site: Annual Volume Effluent From Operations ($yd^3$) |
|---|---|---|---|---|---|
| **Low-Level** | | | | | |
| Liquid | None | None | None | None | None |
| Solid | None | 350 | 117 [a] | 350 | 117[a] |
| **Mixed Low-Level** | | | | | |
| Liquid | None | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) | 0.03 (6 gal) |
| Solid | None | 2 | 2 | 2 | 2 |
| **Hazardous** | | | | | |
| Liquid | Included in solid | None | None | None | None |
| Solid | 0.5 | 1 | 1 | 1 | 1 |
| **Nonhazardous (Sanitary)** | | | | | |
| Liquid | 4,460[b] (900,000 gal) | 70,800[c] (14,300,000 gal) | None[e] | 119,000 (24,000,000 gal) | 119,000 (24,000,000 gal) |
| Solid | 163[d] | 7,400 | 2,470[e] | 7,400 | 2,470[e] |
| **Nonhazardous (Other)** | | | | | |
| Liquid | Included in sanitary | Included in sanitary | None | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 6,400[f] | None | 6,400[f] | None |

[a] Assumes overall compaction factor of 3:1.
[b] Does not include groundwater dewatering, if required.
[c] At a dry site, sanitary, utility, and process wastewaters would be recycled for reuse after treatment.
[d] Includes 20 tons of steel construction waste material which would be recycled as scrap metal.
[e] Assumes overall compaction factor of 3:1.
[f] Recyclable wastes.
Source: DOE 1995g.

### A.2.2.2 *Tritium Recycling Facilities Upgrades at Savannah River Site*

**Missions.** The primary mission of the upgraded tritium recycling facility would be to provide the full range of tritium processing, recycling, and packaging functions performed by DOE, as well as associated testing and waste management functions.

**Assumptions.** The assumptions used in the design of this facility are listed in section A.2.

**General Functions and Layout.** The tritium recycling facilities are centered on the new Replacement Tritium Facility (Building 233-H) and associated support facilities as depicted in figure A.2.2.2–1. The Replacement Tritium Facility was designed for gas handling operations (such as filling and emptying reservoirs), product separation, and enrichment activities. Support activities carried out in the following buildings are described by their assigned names: 232-H Tritium Extraction, Concentration, and Enrichment Facility; 232-1H Tritium Construction Pipe Shop; 232-H Maintenance Shop; 234-H Tritium Reservoir Finishing, Packaging, and Shipping Facility; 235-H Office Building; 236-H Burst Test Facility; 238-H Reservoir Reclamation Facility; 249-H Replacement Tritium Facility Support; and 720-H Central Alarm Station.

The proposed unconsolidated upgrade is designed to meet DOE Natural Phenomenon Hazard Requirements affecting buildings 232-H, 232-1H, 238-H, and 249-H. These upgrades would involve the addition of wall bracing and cross bracing to beams, strengthening some exterior walls, and reinforcing building frames. Building 232-H would also require an anchor for the service area roof slab and an upgrade of the radiation control and monitoring system. Building 234-H upgrades include highly invulnerable encased safes for reservoir storage to protect the tritium filled reservoirs during a high wind and earthquake.

A consolidated upgrade of SRS tritium recycling facilities is also possible. The consolidated upgrade entails the relocation of all tritium processing and handling functions from Building 232-H to buildings 233-H and 234-H in addition to the unconsolidated upgrade modifications. This upgrade would allow Building 232-H to be closed.

**Component Facility Functions.** Many modern nuclear weapons employ tritium gas contained in reservoirs to improve weapon performance. Radioactive decay reduces the reservoir tritium content, which means that stockpile reservoirs must be replaced periodically. The residual tritium from the returned reservoirs is recovered for recycle, and the empty reservoir reclaimed and reused if possible. Reservoirs are subjected to stringent environmental and performance tests to ensure their integrity under all service conditions. The facility also would be the source for tritium used for commercial applications and for fusion research and development.

**Description of Processes.** The tritium recycling facilities processes depicted in figure A.2.2.2–2 would be the same for both the unconsolidated and consolidated upgrades. Tritium would be received in reservoirs returned from the field, or as virgin tritium from an extraction facility associated with a tritium supply facility. The reservoirs would be unpacked from their shipping containers and stored in a vault prior to being emptied.

The reservoirs would be emptied and the contained gases processed to separate the hydrogen isotopes from other gases, primarily helium-3 (a product of the radioactive decay of tritium). The hydrogen isotopes would be separated into tritium, deuterium, and protium (normal hydrogen). Tritium and deuterium would be used to prepare the reservoirs. Protium would be discharged to the stack. The empty reservoirs would be reclaimed, if possible and refilled. Reservoirs that could not be reclaimed would be handled as solid LLW. The helium-3 would be purified to remove any residual tritium and other contaminants prior to packaging as a by-product.

The reclaimed and/or new reservoirs would be filled. The gas could be obtained by using recovered gas of the proper specification, adding pure isotopes to the mix of recovered gases, or blending the pure isotopes. Once the reservoirs have been filled, they would be sealed with a closure weld, trimmed, surface decontaminated, leak tested, inspected, marked, assayed for tritium content, and fitted with an explosively-actuated squib valve, if required. The reservoirs would then be placed in a storage vault until they were packaged and sent to the field for limited life component exchange in a weapon system.

A sampling of the newly-filled reservoirs would be placed in the life storage area for surveillance operations. As these reservoirs age, they would be examined and tested to confirm predicted behavior and to ensure the integrity and function of the reservoirs in the field. Surveillance operations would include environmental testing, functional testing, calorimetry, flow testing, and burst testing. These tests would be performed to evaluate the behavior of the selected reservoirs (including reservoirs returned from the field or in life storage) under test conditions. The tritium recycling facilities would also provide capabilities for metallurgical studies and gas sample composition analyses. The tritium recycling facilities would have the capability to fill containers with specified gas mixtures for commercial use and research applications.

**Facility Utilities.** Facility construction and operation utility requirements are shown in tables A.2.2.2–1 and A.2.2.2–2, respectively.

**Chemicals Required.** Table A.2.2.2–3 depicts the chemical resources required during operation.

**Personnel Requirements.** Upgrade of the tritium recycling facilities would have a peak employment of 26 construction workers for the unconsolidated upgrade and 36 workers for the consolidated upgrade. Approximately 62 worker years would be needed for the unconsolidated upgrade and 91 worker years for the consolidated upgrade during the 3-year construction period. Operation under the unconsolidated upgrade would require 970 workers of which 400 workers would be badged. The consolidated upgrade would require 910 workers of which 400 would be badged.

**Transportation.** Interfacility transfers would be made by DOE contract cargo carriers. Truck service would be needed for intrafacility transport.

**Waste Management.** The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coating. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The upgrade design considers and incorporates waste minimization and pollution prevention. The recovery system would provide the necessary equipment to recover, purify, and package helium-3, and to recover tritium from tritiated wastes generated within the facility, possible offsite sources, and the glovebox inert atmospheres. The recovery system consists of strippers, Z-bed recovery, tritium scrap recovery, and helium-3 recovery. Activities that generate radioactive and hazardous wastes would be segregated, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. After evacuating and flushing with argon, empty reservoirs would be reclaimed, if necessary, and refilled. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Tritium recycling operations would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future decontamination and decommissioning considerations have also been incorporated into the design.

Table A.2.2.2–4 presents the estimated annual waste volumes from the upgraded tritium recycling facilities at SRS during construction and operation. One can expect a reduction in waste generation and effluents once the facility is upgraded. As depicted in figure A.2.2.2–2, solid and liquid waste streams would be routed to the waste management system. Solid wastes would be characterized and segregated into LLW, hazardous, and mixed wastes, then immobilized and packaged for disposal. Liquid wastes would be neutralized, precipitated, and volume reduced via evaporation. The sludge would be

immobilized and packaged for disposal. All fire sprinkler water discharged in process areas during and after a fire would be contained, monitored, sampled, and, if required, retained until it could be disposed of.

*Spent Nuclear Fuel.* The upgraded tritium recycling facilities would not generate any spent nuclear fuel.

*Transuranic Waste.* The upgraded tritium recycling facilities would not generate any TRU waste.

*Low-Level Waste.* Liquid LLW would be generated by hydraulic burst testing and by the strippers; however, the tritium is recovered by Z-bed recovery. Thus, there is no solidification of any liquid LLW. Strippers would be designed to remove hydrogen isotopes, water vapor, and methane from the process waste streams and the glovebox recirculating inert atmosphere.

Strippers consist of four types (process, primary, secondary, and purge) and would utilize a similar process to recover residual tritium from tritiated gases. The process stripper would be designed to remove hydrogen isotopes and water vapor from process waste streams by oxidizing elemental hydrogen isotopes and trapping the oxides on molecular sieves (Z-beds) prior to discharging to the stack. After the bed becomes saturated, it would be heated and the water vapor then routed to tritium aqueous recovery to recover hydrogen isotopes. The primary stripper would be designed to continuously process and recirculate the glovebox nitrogen or argon atmosphere in order to maintain acceptable tritium, water vapor, and oxygen levels inside the glovebox. The secondary stripper would have the same design as a standby unit to process nitrogen gas from gloveboxes when a tritium leak occurs, and also to serve as a spare for the primary stripper. The purge stripper employs the same type of process used in the other strippers to remove hydrogen isotopes and water vapor from the glovebox airlock gas prior to discharging to the stack. The purge stripper also processes the blowdown from the primary and secondary strippers.

Tritium scrap recovery would take tritiated solid wastes such as metals and pieces from reservoir reclamation, metallography, and burst testing; reduce them in size; and then transfer them to a container that would be baked in a vacuum oven. The tritiated off-gas would be evacuated to a storage tank for accountability of tritium prior to transfer to the process stripper. Any pyrophoric materials would be oxidized to promote chemical stability. The solid components would then be cooled in the oven and managed in accordance with the solid LLW procedures outlined below.

Solid LLW would consist of hydride beds, U-bed cartridges, Z-beds, stripper catalysts, retired process equipment, glovebox tools wastes, process metal residues, unreclaimed (empty) reservoirs, and low-specific activity waste. The LLW solids would be reduced in size, immobilized, stabilized, packaged, and then disposed of at one of the E-Area LLW disposal units.

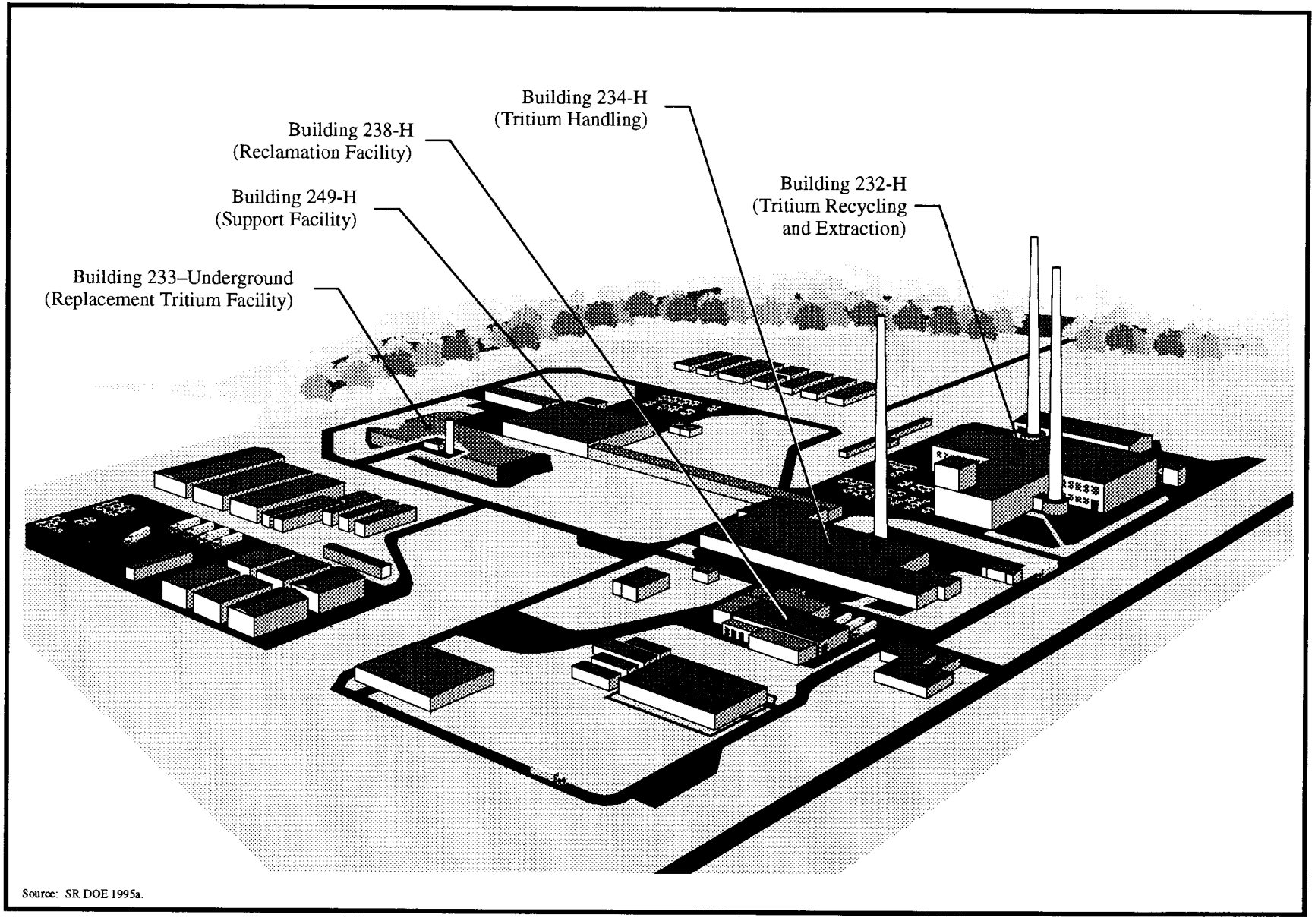
*Hazardous Waste.* Solid hazardous wastes would be generated from nonradioactive materials such as solvent rags, containers with residual hazardous materials, and lead-acid batteries. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to an onsite/offsite RCRA-permitted treatment, storage, and disposal facility. DOT-certified transporters would be used for any offsite shipments.

*Mixed Low-Level Waste.* Liquid mixed LLW would originate from potentially-contaminated used compressor and glovebox bubblers (sealpot) oil. Solid mixed LLW would include solvent rags and oil-contaminated materials with trace quantities of tritium. Mixed LLW would be stored in the RCRA-permitted facility onsite until the permanent disposal method could be determined. The overall management of mixed LLW would be in accordance with the Savannah River Site Treatment Plan, which is currently being developed to comply with the *Federal Facility Compliance Act* of 1992.

*Nonhazardous Waste.* Sewage wastewater would be treated at the onsite Sewage Treatment Plant Number 2 (607-H). Sewage wastewater would be kept separate from all industrial and process wastewaters and normally contains no radioactive wastes from the module. The sewage wastewater would be routinely monitored for radioactive contaminants. The sludge would be disposed of in a permitted landfill. As illustrated in figure A.2.2.2–3, the treated effluent would be discharged through a permitted NPDES outfall.

Industrial wastewater would be treated and discharged through a permitted NPDES outfall. The sludge would be disposed of in a permitted sanitary landfill. Solid industrial, clean-shredded metal, after sanitization and demilitarization, and trash would be collected and sent to a permitted landfill. As shown in figure A.2.2.2–2 the blowdown from the cooling tower and process wastewater would be discharged after treatment directly into the river through an NPDES outfall.

The upgrade design includes stormwater retention facilities with the necessary NPDES monitoring equipment. Rainfall within the facilities area would be collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge into the river. If the runoff is contaminated, it would be treated in the process water treating system. Runoff from outside the facilities area would be discharged directly into the river.




Source: SR DOE 1995a.

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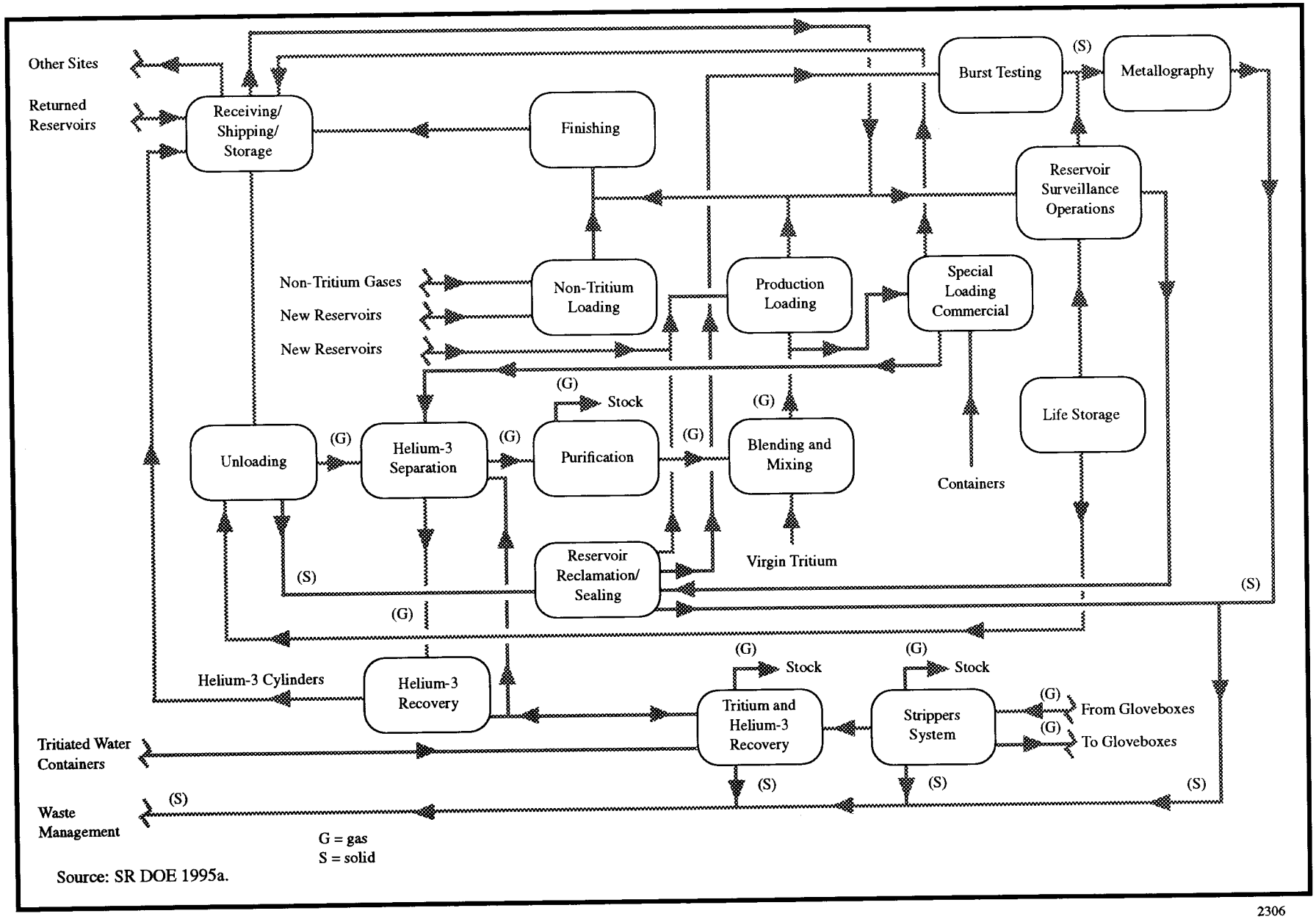
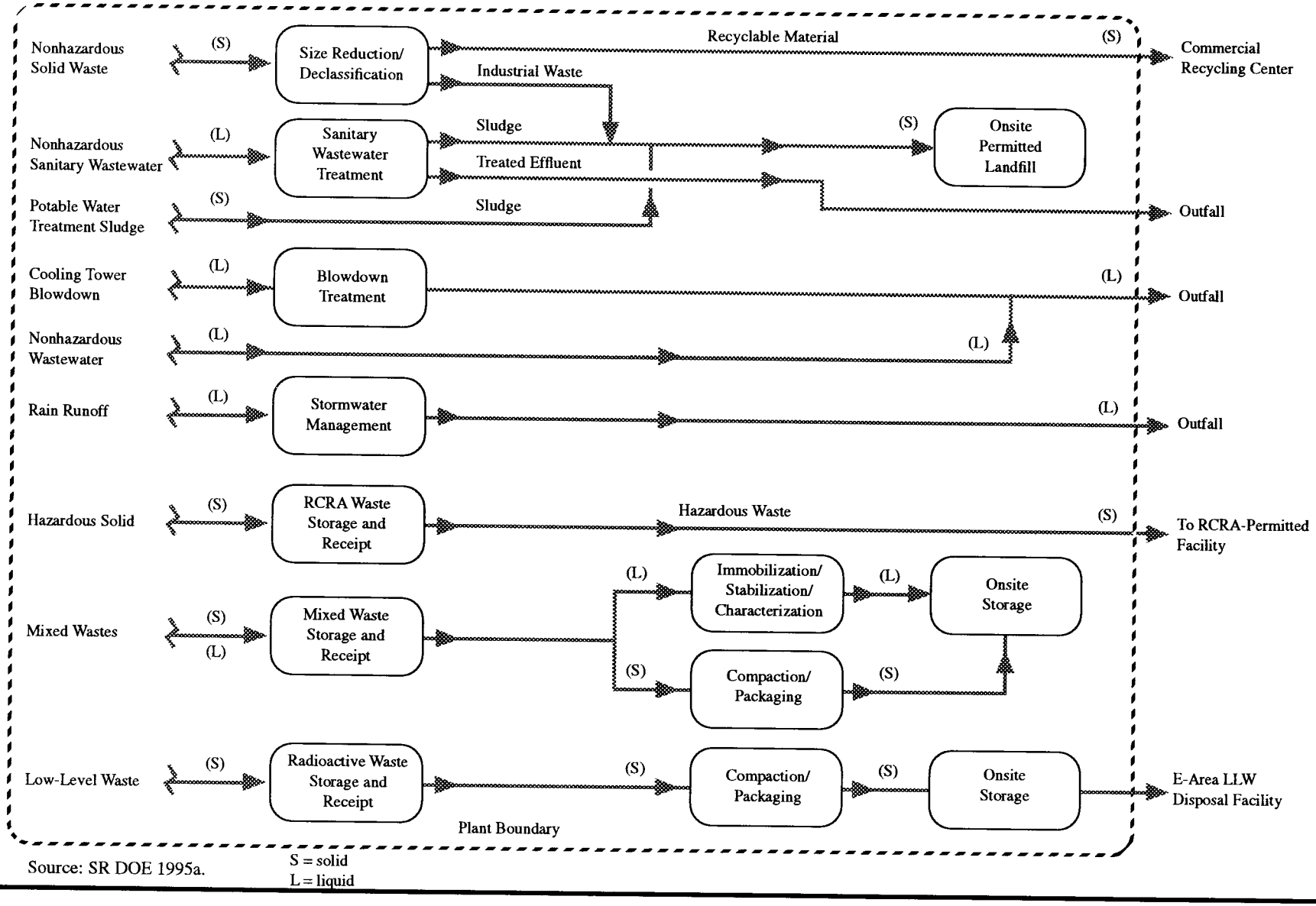
**FIGURE A.2.2.2–1.—*Tritium Recycling Facilities Upgrades at Savannah River Site (Generalized).***




Source: SR DOE 1995a.

**FIGURE A.2.2.2–2.—*Upgraded Tritium Recycling Facilities Processes.***




Source: SR DOE 1995a.

**FIGURE A.2.2.2–3.—*Upgraded Tritium Recycling Facilities Waste Management System.***

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**TABLE A.2.2.2–1.—*Upgraded Tritium Recycling Facilities Construction Material/Resource Requirements***

| Material/Resources | Consumption: Unconsolidated Upgrade | Consumption: Consolidated Upgrade |
|---|---|---|
| Electrical energy (MWh) | 2,000 | 2,000 |
| Concrete ($yd^3$) | 1,900 | 2,100 |
| Steel (tons) | 210 | 240 |
| Fuel (gal) | 16,000 | 17,000 |
| Water (gal) | 130,000 | 140,000 |

Source: SR DOE 1995a.

**TABLE A.2.2.2–2.—*Upgraded Tritium Recycling Facilities Operation Utility Requirements***

| Utility | Consumption: Unconsolidated Upgrade | Consumption: Consolidated Upgrade |
|---|---|---|
| Electrical energy (MWh/yr) | 24,000 | 24,000 |
| Electrical load (MWe) | 3 | 3 |
| Coal (tons) | 5,200 | 5,200 |
| Fuel, liquid (GPY) | 60,000 | 56,000 |
| Water (GPY) | 51,000,000 | 51,000,000 |

Source: SR DOE 1995a.

**TABLE A.2.2.2–3.—*Upgraded Tritium Recycling Facilities Annual Chemical Requirements***

| Chemical | Quantity (lb): Unconsolidated Upgrade | Quantity (lb): Consolidated Upgrade |
|---|---|---|
| **Solid** | | |
| Adhesives, lubricants and paints | 330 | 330 |
| Catalyst and molecular sieves | 800 | 800 |
| Depleted uranium (water decomposer) | 1,500 | 1,900 |
| Other solid chemicals[a] | 1,500 | 1,500 |
| **Liquid** | | |
| Water treatment chemicals[b] | 43,000 | 39,000 |
| Petroleum oils[c] | 550 | 550 |
| Organic solvents[d] | 3,400 | 3,400 |
| Other liquid chemicals[e] | 3,400 | 3,400 |
| **Gaseous** | | |
| Nitrogen | 2,700,000 | 2,800,000 |
| Argon | 170,000 | 170,000 |
| Helium | 450 | 450 |
| Other gaseous chemicals[f] | 8,100 | 8,100 |

[a] Includes calcium nitrate, desiccant, magnesium metal, oxalic acid, Q-wax sealing compound and silica gel.

[b] Includes aluminum sulfate, bentonite, chlorine, diethylaminoethanol, hydrazine, inorganic phosphate, organic phosphate, phosphoric acid, polyelectrolyte, polyphosphate, sodium sulfite and sulfuric acid. May be solid, liquid, or gaseous.

[c] Includes lubricating oils and seal oils.

[d] Includes ethyl alcohol, methanol, refrigerants, paint removers and thinners.

[e] Includes decontamination solutions.

[f] Includes acetylene, hydrogen, deuterium, carbon dioxide, oxygen, methane, methane-argon mixture, and methane-argon-hydrogen mixture.

Source: SR DOE 1995a.

TABLE A.2.2.2–4.—*Upgraded Tritium Recycling Facilities Estimated Waste Volumes*

| Category | Unconsolidated | | | Consolidated | | |
|---|---|---|---|---|---|---|
| | Annual Average Volume Generated From Construction ($yd^3$) | Annual Volume Generated From Operations ($yd^3$) | Annual Volume Effluent From Operations ($yd^3$) | Annual Average Volume Generated From Construction ($yd^3$) | Annual Volume Generated From Operations ($yd^3$) | Annual Volume Effluent From Operations ($yd^3$) |
| **Low-Level Waste** | | | | | | |
| Liquid | None | None | None | None | None | None |
| Solid | None | 350 | 117[a] | None | 350 | 117[a] |
| **Mixed Low-Level Waste** | | | | | | |
| Liquid | None | 0.03 (6 gal) | 0.03 (6 gal) | None | 0.03 (6 gal) | 0.03 (6 gal) |
| Solid | None | 2 | 2 | None | 2 | 2 |
| **Hazardous Waste** | | | | | | |
| Liquid | Included in solid | None | None | Included in solid | None | None |
| Solid | < 0.3 | 1 | 1 | < 0.3 | 1 | 1 |
| **Nonhazardous Waste (Sanitary)** | | | | | | |
| Liquid | 149[b] (30,000 gal) | 158,000 (32,000,000 gal) | 158,000 (32,000,000 gal) | 182[b] (36,700 gal) | 153,000 (31,000,000 gal) | 153,000 (31,000,000 gal) |
| Solid | 14[c] | 7,800 | 2,600[d] | 15[e] | 7,400 | 2,470[e] |
| **Nonhazardous Waste (Other)** | | | | | | |
| Liquid | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary | Included in sanitary |
| Solid | Included in sanitary | 6,800[f] | None | Included in sanitary | 6,400[f] | None |

[a] Assumes overall compaction factor of 3:1.
[b] Does not include groundwater dewatering, if required.
[c] Includes 1 ton of steel construction waste material which would be recycled as scrap metal.
[d] Assumes overall compaction factor of 3:1.
[e] Includes 1.3 tons of steel construction waste material which would be recycled as scrap metal.
[f] Recyclable wastes.
Source: SR DOE 1995a.

## A.3 Tritium Supply Technology Options

Light water reactors have undergone continual design improvements because they are used by the commercial power industry and the ALWR designs presented in this PEIS incorporate these improvements. Potential technological refinements to the MHTGR and HWR technologies that differ from those evaluated in this PEIS are provided below. This section also discusses the feasibility of using the tritium supply technologies to burn plutonium.

### A.3.1 Technology Innovations

#### A.3.1.1 *Gas Turbine Modular Helium Reactor*

The initial MHTGR design for DOE's New Production Reactor Program was a 350 MWt steam cycle plant. The 600 MWt Gas Turbine Modular Helium Reactor represents a different technology, in which the primary helium coolant drives a turbine generator through a gas-compression/gas-expansion, heating/cooling cycle without a phase change. This represents a departure from the conventional steam cycle used in the 350 MWt design, in which steam, produced in the steam generator of the secondary heat exchanger, is used to drive the main turbine generator. In this respect, the Gas Turbine Modular Helium Reactor can be compared to a boiling water reactor in that they are both direct-cycle plant designs. The exception is that the Gas Turbine Modular Helium Reactor uses helium in a single phase for cooling and for driving the turbine. This gas turbine design achieves higher efficiency and reduces the design complexity by eliminating the feedwater and steam systems in the smaller MHTGR plant. The operating conditions of the 600 MWt design plant are elevated above those of the 350 MWt design. The higher operating temperatures, especially the hot helium (core outlet) temperature, provide a further increase in net plant efficiency over the 350 MWt design. Where three 350 MWt modules are considered necessary to meet the current tritium production baseline goal in this PEIS, only two 600 MWt modules would be needed.

**Single Medium System.** Hot helium exits the reactor core, flows through the center hot duct within the cross vessel, and expands through the turbine. The turbine directly drives the electrical generator, the low pressure compressor, and the high pressure compressor. Helium exits the turbine and flows through the high efficiency plate-fin recuperator to return as much energy as possible to the cycle, then finally flows through the precooler to reject heat to the ultimate heat sink. Cold helium enters the intercooler compressor and passes through the recuperator. The helium then flows from the recuperator exit, through the outer annulus within the cross vessel, past the reactor vessel walls for vessel cooling, and finally down through the core to complete the loop.

**Reactor Module.** The reactor module arrangement of the 600 MWt design is similar to that of the 350 MWt design. The steam generator vessel of the 350 MWt design is replaced with a slightly larger diameter power conversion vessel in the 600 MWt design. The reactor and power conversion vessels are vertically positioned and connected by a coaxial cross vessel. The fuel particle and fuel element designs are identical, as are the lithium target particles, compacts, and assemblies.

Both reactor module designs refuel on the same schedule. Each design has a nominal 3-year residence time for the fuel, and one-third of the fuel blocks would be replaced annually. The target assemblies in all the fuel and reflector blocks would be replaced semiannually for the tritium supply mode.

**Power Conversion Module.** The power conversion vessel would contain the turbomachine, generator, recuperator, precooler, and intercooler. The basic function of this power conversion module is to convert heat energy to electrical energy and to provide the motive force for the helium primary coolant. A significant feature of the 600 MWt design turbomachine assembly is that the turbine, the two compressors, and the submerged generator would all be mounted on a single, vertical shaft. This would enable using a vertical power conversion vessel, be the most space efficient, and allow the removal of the turbomachine by the reactor building crane. Using a generator that is submerged within the helium primary coolant would eliminate the need for rotating shaft penetrations of the primary pressure boundary. Also, the turbomachine assembly would incorporate an active magnetic thrust bearing and three to five magnetic journal bearings. With this non-contact type of bearing, no bearing lubricants or coolants

would be required, and bearing power losses would be minimal.

**Recuperator.** The recuperator is a helium-to-helium heat exchanger included in the 600 MWt design. This heat exchanger would recover energy from the helium exiting the turbine and would utilize that energy to preheat the compressed helium before it enters the reactor. This recovery process would assist in achieving a net plant efficiency of approximately 48 percent compared to approximately 38 percent for the 350 MWt steam cycle design.

**Precooler and Intercooler.** The precooler and intercooler heat exchangers would be included in the power conversion loop of the 600 MWt design to reduce the temperature of the helium primary coolant prior to entering the inlets to the low pressure and high pressure compressors. This cooling process would reduce the work required to compress the helium in the compressors, thereby enhancing the net plant cycle efficiency.

**Environmental Impacts.** There are no substantial overall differences between the two-module 600 MWt Modular Helium Reactor and the three-module 350 MWt MHTGR. Compared to the MHTGR, the Modular Helium Reactor would have slightly more environmental impact in some resource areas, and slightly less environmental impact in other resource areas. A two-module 600 MWt Modular Helium Reactor would generate approximately 3 percent more spent nuclear fuel, increase worker doses, increase normal operational releases of some radioactive constituents, and increase the accident source term. Potential decreases in environmental impacts could result from less construction, decreased tritium releases during normal operations, reduced operating personnel, and less cooling water requirements.

### A.3.1.2 *Small Advanced Heavy Water Reactor*

A reduced capacity HWR design does not now exist but could be developed to produce tritium at a level to meet the steady-state (3/16 goal) tritium requirement, but would have the capability, if necessary, to be modified to meet baseline (3/8 goal) tritium production requirements. The HWR evaluated in all other sections of this PEIS represents a downsized 8/8 goal quantity design from the original New Production Reactor Program operated at the steady-state level.

The small advanced HWR would be designed for a nominal thermal output of approximately 470 MWt with a deep burn fuel cycle using uranium fuel. This would enable the small advanced HWR to produce steady-state (3/16 goal) tritium requirements. It would have the ability, with pre-planned plant upgrades and operational changes, to operate at a higher power level and produce the baseline 3/8 tritium goal quantity (DOE 1995a:1).

Specific design and operational features would be incorporated into the basic design to facilitate the modifications necessary to increase the tritium production to the 3/8 goal in a timely manner. These include the addition of fuel/targets into vacancy positions; operating at a higher capacity factor; reducing the fuel cycle duration; operating the reactor at a higher power density; and oversizing and making provisions for additional heat rejection system components (e.g., adding cooling tower cells).

**Key Design Improvements.** The layout and design of the small advanced HWR would be similar to the 3/8 concept with the primary difference being a more compact, and modularly designed facility. The small advanced HWR facility would occupy about 40 to 50 acres (within the limited access fence) as compared to 60 acres for the 3/8 design. The total area planned to be disturbed for the purpose of constructing and operating the small advanced HWR would be approximately 150 to 170 acres.

Because of the smaller plant configuration, the construction schedule will be shortened from the current design. Construction of the small advanced HWR complex would require approximately 5 years and 1,800 workers during the peak construction period.

Additional design improvements for the small advanced HWR would be a reduced number of systems consistent with passive reactor safety requirements; smaller heavy water inventory and lower primary coolant flow rates translating into smaller equipment and piping sizes; reduced shielding requirements based on reduced source terms and use of robotics; and smaller building sizes and concomitant reductions in bulk material quantities.

The small advanced HWR fuel/targets, core configuration, and primary reactor coolant system would be similar to, but notably smaller than, the HWR described in sections 3.4.2.1 and A.2.1.1. Outlying buildings, cooling towers, switchyard, and overall plant footprints dimensions would also be reduced for the small advanced HWR.

Some differences of key parameters between the small advanced HWR and the HWR design evaluated in this PEIS would be 470 MWt versus 990 MWt, 144 fuel/target assemblies versus 258, and a containment building which is less than 120 feet in diameter versus 140 feet. The design would still maintain the two reactor coolant loops with some reduction in the piping, heat exchanger, pressurizer and accumulator sizes. Also, the fuel cycle duration would be retained at 350 days with an annual capacity factor of 85 percent.

It should be emphasized that the description of the small advanced HWR represents a pre-preconceptual design based on knowledge of existing HWR designs, recent requirements for advanced light water reactors, and the varied production requirements defined in section 3.1.1.

### A.3.2 Plutonium Disposition

This PEIS analyzes technology options that have been determined to be reasonable for the mission of producing tritium required for continuing stockpile support only. The ALWR and the MHTGR technologies offer the added benefit of being capable of producing steam for electricity production that could prove to be desirable in offsetting operational and capital costs. The HWR cannot produce steam efficiently and the APT cannot produce steam at all. The ALWR and a Gas-Cooled Modular Helium Reactor are under consideration to fulfill roles in the ultimate disposition of fissile materials declared surplus to national defense needs, particularly plutonium.

The current and planned dismantling of large quantities of the nuclear weapons in the Nation's stockpile has and will result in the generation of excess quantities of plutonium. Various alternatives have been considered which would place excess plutonium into relatively inaccessible forms conforming with the "spent fuel standard", in which the remaining plutonium is made as inaccessible for retrieval and weapons use as the residual plutonium in spent nuclear fuel from commercial power reactors. Among these is the use of plutonium-based reactor fuels and the immobilization of diluted plutonium through vitrification in ceramic or metal immobilization techniques. Other options use accelerator or reactor-generated neutrons to virtually destroy plutonium through deep burn fissioning. The reactor technologies considered for tritium production could be used to fulfill a part of or all of the requirements for plutonium disposition. However, other alternatives are also under consideration for plutonium disposition, such as direct disposal to deep boreholes and use of reactors in other countries, that do not use tritium production technologies. Clearly, plutonium disposition alternatives should not be limited to those technologies that support tritium production uniquely. However, if a reactor were to be selected as the tritium supply technology, it will be evaluated by the plutonium disposition program to determine if partial requirements can be met. The Office of Fissile Materials Disposition is expected to publish an Implementation Plan in March 1995, which describes the alternatives that will continue to be evaluated for plutonium disposition.

The National Academy of Science's report *Management and Disposition of Excess Weapons Plutonium* (NAS 1994a) did not consider a linkage between tritium production and plutonium disposition technologies to necessarily be desirable. The wider range of options available for plutonium disposition and the smaller capacity required for tritium production are cited as countervailing to linkage. The production of tritium in the same facilities that might also be used to dispose of weapons materials, which would fall under International Atomic Energy Agency safeguards, is also cited as a potentially concern. The National Academy of Science committee also concluded that the cost savings from a dual purpose, tritium production/plutonium disposition technology strategy would not be great and might not be justified when balanced against the complications discussed above.

Excess plutonium materials are considered appropriate for use in reactor fuel and disposal as reactor spent fuel for three basic reasons:

- It would meet the "spent fuel standard", and

- There is a path forward for material that meets the "spent fuel standard", i.e., ultimate disposition in a repository, and

- It may result in equivalent reciprocal actions from the Russians.

Each of the tritium supply technology alternatives is discussed below for plutonium disposition.

### A.3.2.1 *Advanced Light Water Reactor Technology*

This PEIS evaluates the ALWR technology alternative for both large and small reactor versions for tritium production. The reactor models under evaluation for plutonium disposition include light water reactors. The four primary design concepts are:

- ABB-Combustion Engineering Pressurized Light Water Reactor, System 80+.

- General Electric Advanced Boiling Water Reactor (GE ABWR).

- Westinghouse Pressurized Light Water Reactor, PDR-1400.

- Westinghouse Pressurized Light Water Reactor, AP-600.

Without major modifications, typical light water reactors could burn a fuel consisting of mixed oxides of plutonium oxide and uranium oxide in their reactor cores. Some light water reactors are designed to use mixed oxides in 100 percent of their reactor cores. A number of operating or partially completed reactors could be modified to use full mixed oxide cores, or a new full mixed oxide reactor could be built with costs partly offset by later sales of electricity. Although the United States has no operating mixed oxide-fuel fabrication plant or mixed oxide-fuel burning reactors today, this technology is technically demonstrated by the burning of mixed oxide fuels in several light water reactors in other countries, and has been demonstrated by use in several U.S. reactors in the 1970's.

Burning mixed-oxide fuel in an ALWR would result in creating inaccessible forms of plutonium conforming with the "spent fuel standard." The ALWR designs could be adapted for dual tritium production and plutonium burning on essentially a non-interference basis. Some thermal power degradation could occur as a result of producing tritium, but not a significant amount. Also, the cyclic tritium production campaigns and the effect that this might have on the fuel burn cycle might not maximize the annihilation of plutonium fuel constituents. Only one reactor of the models shown would be required for tritium production. If only one Large ALWR were used as the principal technology to dispose of excess plutonium, approximately 50 metric tons of plutonium could be disposed of over the 40-year reactor life. For the AP-600, approximately half this amount could be disposed of over the 40-year reactor life.

**ABB-Combustion Engineering System 80+.** The Combustion Engineering System 80+ is a standard pressurized water reactor design which incorporates evolutionary improvements to the System 80 design in operation at the Palo Verde Nuclear Generating Station. The Combustion Engineering System 80+ improvements include a ring-forged reactor vessel, greater design margins for major components, and improvements to safety systems. NRC issued final design approval on ABB-Combustion Engineering's 1,300 MWe System 80+ pressurized water reactor in July 1994.

The Combustion Engineering System 80+ design would preserve the System 80 design feature of accommodating mixed-oxide fuel loadings up to and including a full mixed-oxide reactor core loading. The higher decay heat loads after shutdown generated by a full mixed oxide reactor core would be accommodated in the design of the various heat removal systems, the shutdown cooling system, spent nuclear fuel pool cooling system, and the component cooling water system.

The Combustion Engineering System 80+ design would maintain flexibility in its power output depending on the mode of power operation. As a uranium oxide fueled power production plant, the core thermal rating would be 3,914 MWt. When loaded with mixed oxides, the output would be 3,817 MWt. And, when operating as a tritium producer while loaded with uranium oxide, the output would be 3,410 MWt.

**Westinghouse Pressurized Water Reactors.** The Westinghouse Electric Corporation's pressurized water reactor AP600 is a 600 MWe nuclear power plant that has a simpler overall design than other Westinghouse plants. The AP600 design includes enhanced safety margins in such areas as fuel rod thermal limits and corrosion protection features. The AP600 would use a natural circulation heat exchange loop connected to the reactor and located inside the containment for reactor residual heat removal. Application for approval is under review by the NRC for Westinghouse Electric Corporation's AP600 design.

This advanced pressurized water reactor system is projected to have the capability of producing tritium with either plutonium oxide or uranium oxide as fuel. To operate in this mode, the core assembly structure would need to be altered such that some light water reactor tritium-producing rods would replace some fuel rods. The impact this would have on thermal-hydraulic compatibility and passive safety remains to be evaluated. The PDR-1400 is an evolutionary reactor similar to the four loop Westinghouse designs of existing pressurized water reactors.

**General Electric Boiling Water Reactor.** General Electric has applied recent technology innovations to the development of an advanced design of its currently operating boiling water reactors. The 1,300 MWe Advanced Boiling Water Reactor focuses on overall plant simplification and the use of safety systems that do not require operator actions. The major innovations that have been made in the systems would rely on gravity or stored energy to ensure core cooling and decay heat removal. The NRC issued final design approval for General Electric's 1,300 MWe Advanced Boiling Water Reactor in July 1994.

The Advanced Boiling Water Reactor was originally designed to utilize full core loads of mixed-oxide fuel. The physical design of the core and the boiling water reactor core dynamics are such that no modifications to the reactor system are required for the use of mixed oxide fuel over a wide range of plutonium loadings. If necessary, the Advanced Boiling Water Reactor has the flexibility to easily switch back to conventional uranium fuel, again without plant physical changes.

### A.3.2.2 *Modular High Temperature Gas-Cooled Reactor Technology*

The MHTGR design evaluated in this PEIS for a tritium mission is based upon a 350 MWt steam cycle plant. In order to increase thermal efficiency, a direct cycle Gas Turbine Modular Helium Reactor pre-pre-conceptual design which could produce tritium as well as be used for plutonium disposition has been suggested. The module power rating for this reactor would be increased to 600 MWt. Where three 350 MWt MHTGR modules would be required to meet baseline tritium production requirements, only two 600 MWt Modular Helium Reactor modules would be required. The new Gas Turbine Modular Helium Reactor design is under evaluation for plutonium disposition purposes and is represented by the General Atomics 600 MWt design described in Section A.3.1.1. This reactor is designed to actually destroy plutonium through deep burn fissioning which results in a net plutonium destruction rate of approximately 65 percent. The technical, research and development, and demonstration requirements necessary to be completed for the Modular Helium Reactor substantially increase the technical, schedule, and cost risks of bringing this concept to maturity.

The Modular Helium Reactor could not be adapted for both tritium production and plutonium burning in a non-interference manner. The tritium production efficiency decreases by a factor of four when using plutonium fuel in a Modular Helium Reactor. Thus, utilizing the Modular Helium Reactor for tritium production of 3/8 goal quantities with plutonium fuel would require eight reactor modules as opposed to two with uranium fuel. This factor of four increase in the number of required 600 MWt Modular Helium Reactors is directly attributable to the fact that tritium targets can only be placed in the reflector material of the plutonium-fueled core and not also within the fueled region of the core as they can with a uranium-fueled reactor. This limitation of the plutonium-consumption Modular Helium Reactor serves to reduce by a factor of four the number of targets in each reactor available to produce the required amount of tritium, and thus increases the number of required plutonium-fueled reactor modules by the same factor.

Correspondingly, assuming that it is possible to extrapolate this data from the 600 MWt direct cycle gas turbine reactor technology to the 350 MWt

MHTGR technology proposed for tritium production, the three 350 MWt reactors proposed to produce the 3/8 goal quantity of tritium utilizing uranium fuel would need to be increased by a factor of four if plutonium fuel were utilized. This would result in a requirement of twelve 350 MWt MHTGR modules to produce the 3/8 goal quantity of tritium. However, only six 350 MWt MHTGRs would be required to produce the steady-state (3/16 goal) requirement. In the event that surge tritium production were required, some of the six 350 MWt reactors could be refueled with uranium fuel in order to allow for increased placement of target rods in the core, and thus meet the surge requirement.

It is not expected that the six 350 MWt reactors could dispose of the same amount of plutonium as one large ALWR over the 40 year reactor life. The inefficiencies induced by using a dual purpose strategy are not entirely known. However, it could be expected that tritium production cycle interrupts would cause some minor delays in the plutonium disposition timetable.

#### A.3.2.3 *Heavy Water Reactor Technology*

An advanced HWR design for tritium production could possibly use plutonium fuel. The plutonium burn-up for such a reactor is estimated to be 35 percent. If a single HWR at the power level required to produce the annual goal quantity of tritium were used for plutonium disposition then approximately 70 years would be required to dispose of 50 tons of plutonium. Since this time frame is greater than the expected life of such a reactor, two reactors would be required. If selected for tritium supply, the HWR would then be evaluated for a plutonium disposition mission.

#### A.3.2.4 *Accelerator Production of Tritium Technology*

Accelerator-based conversion technologies have been investigated as possible plutonium disposition alternatives. Accelerator-based conversion would use a sub-critical reactor augmented by an accelerator to "deep burn" plutonium, which could eliminate in excess of 90 percent of the processed plutonium over the campaign. This technique would allow plutonium disposition to progress well beyond the "spent fuel standard." The technique involves the use of particle accelerator module, at the appropriate power level, that is used as the precursor for the APT alternative evaluated in this PEIS.

The target systems are, however, quite different. For plutonium disposition, either molten salt or particle bed systems could be used. In both cases, materials containing surplus plutonium particles would be irradiated with neutrons until a large portion of the plutonium was eliminated through fissioning. Excess commercial power could not be generated with this scheme in order to exploit the energy value of the plutonium; however, enough power could be generated to operate the particle accelerator once started. In theory, an accelerator-based system could provide plutonium disposition services as well as produce tritium; however, one process would compete with the other for neutrons. For plutonium "deep burn" disposition, it is estimated that up to three accelerator-based facilities with four target blankets arrays each would be required for a twenty year disposition campaign. Only one such facility with two lithium-6 target-blanket systems (or continuous helium-3 target systems) would be required to produce anticipated annual quantities of tritium.

This option is only at the early paper study stage and would not be available on a large scale for decades. If the estimated performance could be attained, however, such systems could destroy plutonium at a rate (per unit of thermal energy) comparable to those of the other destruction-oriented options (e.g., reactors) and could reach high reduction factors for plutonium inventory more rapidly than many of the other options.

# APPENDIX B

# Appendix B

# APPENDIX B: AIR QUALITY AND ACOUSTICS

## B.1 AIR QUALITY

### B.1.1 Introduction

This appendix provides detailed data that support impact assessments to air quality and acoustics addressed in the Tritium Supply and Recycling Programmatic Environmental Impact Statement (PEIS) sections 4.X.2 Affected Environment and 4.X.3 Environmental Impacts. The data presented include background or ambient concentrations of criteria pollutants, emission inventories from site-related activities, and tritium supply and recycling related emissions. The tables included in sections B.1.3.2 through B.1.3.6 contain site-specific baseline information applicable to air quality assessments. Section B.1.4 contains air quality emissions data relative to the tritium supply technologies and recycling options considered in the program. Figures B.1.3.2–1, B.1.3.3–1, B.1.3.4–1, B.1.3.5–1, and B.1.3.6–1 contain wind rose data pertinent to the analysis of air emissions effects from baseline and No Action and also from tritium supply and recycling. Locations of air monitoring stations from which air quality data were collected are provided in figures B.1.3.2–2, B.1.3.4–2, and B.1.3.6–2.

### B.1.2 Methodology and Models

The assessment of potential impacts to air quality is based upon comparison of proposed project effects with applicable standards and guidelines. The assessment of these emissions used the Industrial Source Complex Short-Term model recommended by the tiered *National Environmental Policy Act* (NEPA) of 1969 documents for point, area and volume sources, which estimates dispersion of emissions from these sources.

The performance of the Industrial Source Complex Short-Term model has been evaluated with field data for its point source submodel (EPA 1977a; EPRI 1983a; EPRI 1985a; EPRI 1988a) and for its special features, such as gravitational settling/dry deposition option (EPA 1981a; EPA 1982a) and building downwash option (APCA 1986a; EPA 1981a). From the validation studies for the point source model (the CRSTER model) based on field data measured at four large power plants, it was concluded that the model acceptably predicts the upper percentile of the frequency distribution of 1-hour concentrations and of the corresponding distributions of 24-hour concentrations. Concentrations over the remainder of the frequency distributions are significantly underpredicted. The second-highest 1-hour concentrations were predicted within a factor of two at two-thirds of the field sampling sites for elevated power plant plumes. The second-highest 24-hour concentrations tended to be underpredicted by the model, with the ratio of predicted concentration to measured concentration ranging from about 0.2 to 2.7 at about 90 percent of the sampling sites (EPA 1977a).

In other validation studies for the point source model, the CRSTER model predicted peak short-term (1-, 3-, and 24-hour) concentration values within 30 to 70 percent at a plain site (EPRI 1983a). The CRSTER model predicted peak 1-hour concentrations within 2 percent and underpredicted peak 3-hour concentrations by approximately 30 percent at a moderately complex terrain site (EPRI 1985a). The Industrial Source Complex Short-Term model overpredicted 1-hour concentrations by approximately 60 percent with better predictions for longer time periods at an urban site (EPRI 1988a). Uses of gravitational settling/dry deposition and building downwash options were found to improve the model performance significantly over that of the model without such features (APCA 1986a; EPA 1981a; EPA 1982a).

The air quality modeling analysis performed for the candidate sites is a "screening level" analysis incorporating conservative assumptions applied to each of the sites such that the impacts associated with the respective alternatives could be compared among the sites. These conservative assumptions will overestimate the pollutant concentrations at each of the sites.

The assumptions incorporated into the air quality modeling at each site are as follows: major source criteria pollutant emissions were modeled using actual source locations and stack parameters to

determine environmental baseline and No Action criteria pollutant concentrations; toxic/hazardous pollutant emissions were modeled from a single source centrally located on each site assuming a ten meter stack height, a stack diameter of one foot, stack exit temperature equal to ambient temperature, and a stack exit velocity equal to 0.01 meters per second.

Emissions from the tritium supply and recycling facilities were located at the tritium supply site (TSS) identified for each site assuming a single stack ten meters in height, a stack diameter of one foot, stack exit temperature equal to ambient temperature, and stack exit velocity equal to 0.01 meters per second.

These assumptions would tend to overestimate pollutant concentrations since no credit is given to spatial and temporal variations of emission sources.

Potential impacts on air quality from construction were assessed on a qualitative basis. A more detailed and quantitative assessment will be done in the site-specific NEPA documents. This PEIS assessment of impacts from operation of the alternatives under consideration used a "screening" level analysis and was based on conservative assumptions for modeling of potential impacts. The assessment in the site-specific tiered NEPA documents would be more refined, with detailed design source characteristics and exact source emission locations.

## B.1.3 Supporting Data

### B.1.3.1 *Overview*

This section provides supporting information related to the meteorology for each of the five candidate sites for tritium supply and recycling. Table B.1.3.1–1 presents the air quality standards applicable to each site, while table B.1.3.1–2 presents maximum allowable Prevention of Significant Deterioration concentration increments also applicable to each site. Additional tables are presented within the discussion for each site for background monitoring stations and applicable air monitoring data, and relevant emissions inventory. Figures depicting annual wind direction frequencies and mean wind speeds for each site and locations of ambient air quality monitoring stations are presented for those sites which conduct monitoring of ambient air quality.

**TABLE B.1.3.1–1.—*Ambient Air Quality Standards Applicable to the Candidate Sites***

| Pollutant | Averaging Time | Primary NAAQS[a] ($\mu g/m^3$) | Secondary NAAQS ($\mu g/m^3$) | Idaho[b] (INEL) ($\mu g/m^3$) | Nevada (NTS) ($\mu g/m^3$) | Tennessee (ORR) ($\mu g/m^3$) | Texas (Pantex) ($\mu g/m^3$) | Georgia and South Carolina (SRS) ($\mu g/m^3$) |
|---|---|---|---|---|---|---|---|---|
| **Criteria Pollutant** | | | | | | | | |
| Carbon monoxide | 8-hour | 10,000 | c | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| | 1-hour | 40,000 | c | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 |
| Lead | Calendar Quarter | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Nitrogen dioxide | Annual | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Ozone | 1-hour | 235 | 235 | 235 | 235 | 235 | 235 | 235 |
| Particulate matter | Annual | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| | 24-hour | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| Sulfur dioxide | Annual | 80 | c | 80 | 80 | 80 | 80 | 80 |
| | 24-hour | 365 | c | 365 | 365 | 365 | 365 | 365 |
| | 3-hour | c | 1,300 | 1,300 | 1,300 | 1,300 | 1,300 | 1,300 |
| **Other Mandated Pollutants** | | | | | | | | |
| Beryllium | 24-hour | c | c | c | c | c | 0.01 | c |
| Hydrogen fluoride | 30-day | c | c | c | c | 1.2 | 0.8 | 0.8 |
| | 7-day | c | c | c | c | 1.6 | 1.6 | 1.6 |
| | 24-hour | c | c | c | c | 2.9 | 2.9 | 2.9 |
| | 12-hour | c | c | c | | 3.7 | 3.7 | 3.7 |
| Hydrogen sulfide | 1-hour | c | c | c | 112 | c | c | c |
| Total suspended particulates | Annual | c | c | 60 | 75 | 60[d] | c | 75 |
| | 24-hour | c | c | 150 | 150 | 150[d] | c | c |

[a] The National Ambient Air Quality Standards, other than those for ozone, particulate matter, and those based on annual averages, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per year with maximum Hourly average concentrations above the standard is less than or equal to one. The 24-hour particulate matter standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to one. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[b] The Idaho annual standards are never to be exceeded; short-term standards are not to be exceeded more than once per year, unless otherwise noted.

[c] There is no standard.

[d] Total suspended particulate standards listed are secondary standards. Annual and 24-hour primary standards are 75 and 260 $\mu g/m^3$, respectively.

Note: NAAQS - National Ambient Air Quality Standard.

Source: 40 CFR 50; IN DHW 1990b; SR DHEC 1992b.

**TABLE B.1.3.1–2.—*Maximum Allowable Prevention of Significant Deterioration Concentration Increments for the Candidate Sites***

| Pollutant | Averaging Time | Prevention of Significant Deterioration Increment[a] ($\mu g/m^3$) | | |
|---|---|---|---|---|
| | | Class I | Class II | Class III |
| Nitrogen dioxide | Annual | 2.5 | 25 | 50 |
| Particulate matter | Annual | 4 | 17 | 34 |
| | 24-hour | 8 | 30 | 60 |
| Sulfur dioxide | Annual | 2 | 20 | 40 |
| | 24-hour | 5 | 91 | 182 |
| | 3-hour | 25 | 512 | 700 |

[a] Short-term increments are not to be exceeded more than once per year.

Note: PSD - Prevention of Significant Deterioration.

Source: 40 CFR 52.21.

### B.1.3.2 *Idaho National Engineering Laboratory*

This section provides information on meteorology and climatology, atmospheric dispersion characteristics, annual mean wind speeds and direction frequencies (figure B.1.3.2–1), and locations of ambient air quality monitoring stations (figure B.1.3.2–2) at the Idaho National Engineering Laboratory (INEL). Tables B.1.3.2–1 and B.1.3.2–2, respectively, present air quality monitoring data and emission source inventories for criteria pollutants. Table B.1.3.2–3 presents Prevention of Significant Deterioration Sources and nearby Class I areas. Tables B.1.3.2–4 and B.1.3.2–5, respectively, present emission rates and maximum site boundary concentrations of toxic/hazardous air pollutants and estimated ambient concentrations of criteria pollutants from baseline sources. This information supports data presented in section 4.2.2.3.

**Meteorology and Climatology**. Prevailing wind directions at INEL are from the southwest to west-southwest with a secondary maximum frequency from the north-northeast to northeast. Figure B.1.3.2–1 shows annual wind direction frequencies and mean wind speeds for 1986 at the 33-foot level of the INEL meteorological tower. The annual average wind speed measured at the 20-foot level at the Central Facilities Area Weather Station is 7.5 mph. Monthly average wind speeds range from 5.1 mph in December to 9.3 mph in April and May.

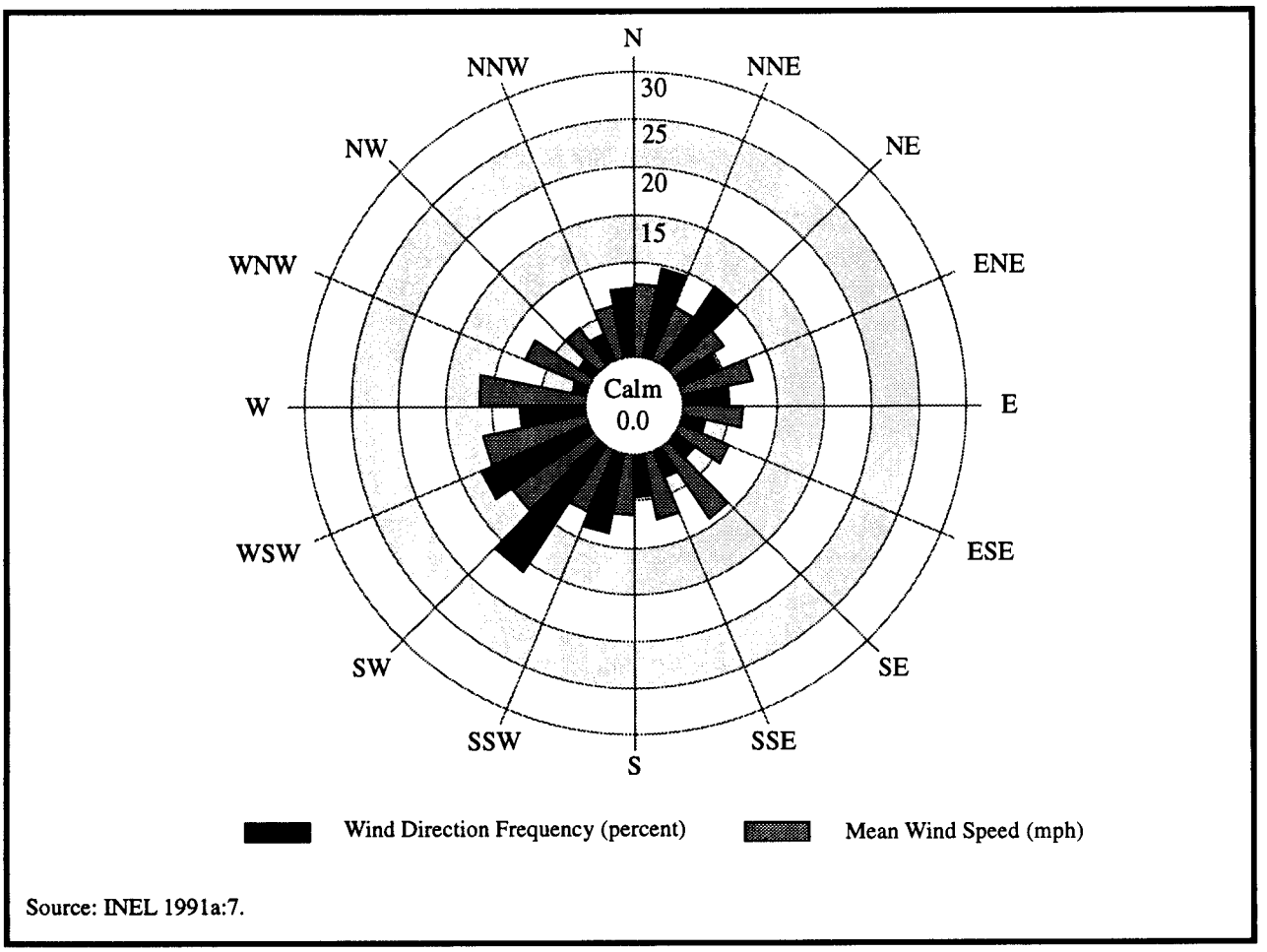
The annual average temperature at INEL is 42 °F; monthly averages range from 16 °F in January to 68 °F in July (NOAA 1991d). The annual average relative humidity is 50 percent, with monthly average values ranging from 30 percent in July to 70 percent in February.

The average annual precipitation at INEL is 9.1 inches. The average monthly precipitation ranges from 0.40 inches in July to 1.28 inches in May. A large portion of the precipitation occurs as snow during winter. The average annual snowfall is 42.6 inches.

The maximum instantaneous wind gust recorded at the Central Facilities Area Weather Station (20-foot level) was 78 mph from the west-southwest, and the maximum hourly average wind speed, also from the west-southwest, was 51 mph (IN DOE 1989b).

The months of June, July, and August each average two to three thunderstorm days. Hail storms occur occasionally, with the hail usually smaller than 0.25 in diameter. Tornadoes are very infrequent in the area. Between 1950 and 1989, a total of five funnel clouds and no tornadoes were sighted within the boundary of INEL. The estimated probability of a tornado striking a point at INEL is 6 in 10 million per year (NRC 1986a).

**Atmospheric Dispersion Characteristics.** Data collected at the Central Facilities Area Weather Station for calendar year 1986 indicate that unstable conditions occur approximately 38 percent of the time, neutral conditions approximately 4 percent of the time, and stable conditions approximately 58 percent of the time, on an annual basis.




Source: INEL 1991a:7.

**FIGURE B.1.3.2–1.—*Wind Distribution at Idaho National Engineering Laboratory, 1986 (33-foot level).***

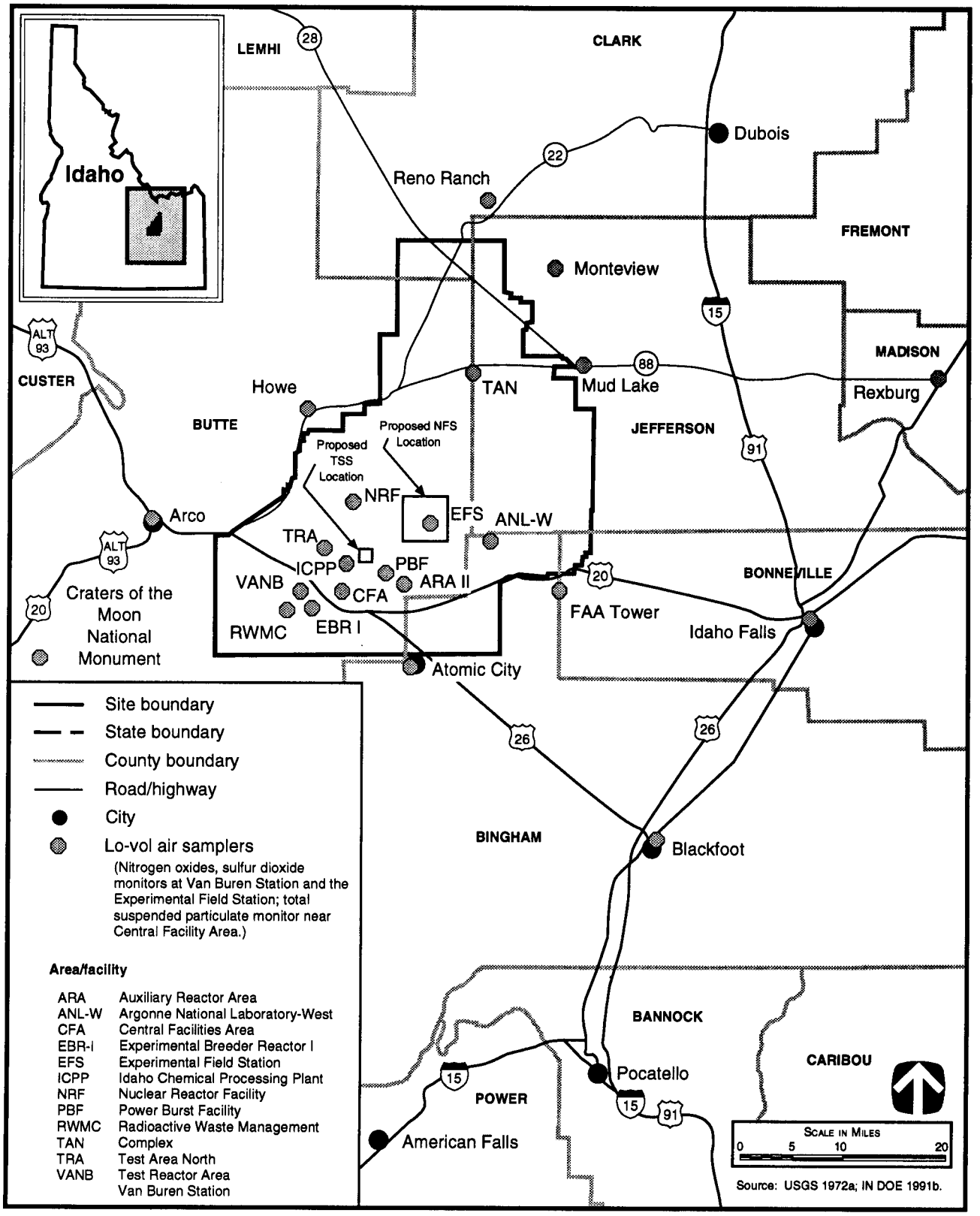



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**FIGURE B.1.3.2–2.**—*Idaho National Engineering Laboratory Ambient Air Quality Monitoring Network.*

**TABLE B.1.3.2–1.—*Ambient Air Quality at Idaho National Engineering Laboratory***

| Monitoring Station | Time Period | Ambient Concentration (μg/m³) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Sulfur Dioxide | | | Nitrogen Oxide | Particulate Matter | | Total Suspended Particulates[a] | |
| | | Annual | Max. 24-hour | Max. 3-hour | Annual | Annual | Max. 24-hour | Annual | Max. 24-hour |
| Central Facility Area | July 1989-June 1990 | b | b | b | b | 14 | 32 | 40 | 88 |
| Experimental Field Station | Jan. 1990-Dec. 1990 | b | b | b | 5.0 | b | b | b | b |
| Van Buren Station | Oct. 1989-Mar. 1991 | 0.2 | 8.0 | 14.0 | b | b | b | b | b |

[a] Total suspended particulates data taken from DOE 1992.

[b] Not measured.

Note: Carbon monoxide, lead, and ozone not measured at this site.

Source: DOE 1992h; DOE 1992i; DOE 1992k; IN DOE 1990a; IN DOE 1991c.

**TABLE B.1.3.2–2.—*Source Emission Inventory for Idaho National Laboratory, 1989***

| Source | Criteria Pollutant – Emission Rate (lb/hr) | | | | |
|---|---|---|---|---|---|
| | Carbon Monoxide | Lead | Nitrogen Oxide | Particulate Matter | Sulfur Dioxide |
| Argonne National Laboratory–West 18 | 9.6 | 0.000514 | 1.26 | 3.74 | 13.9 |
| Argonne National Laboratory–West 19 | 0.55 | 0.000010 | 0.017 | 0.18 | 0.25 |
| Central Facilities Area 20 | 6.21 | 0.000449 | 1.05 | 25.6 | 12.2 |
| Central Facilities Area 21 | 0.64 | 0.000046 | 0.16 | 0.26 | 1.25 |
| Idaho Chemical Processing Plant 22 | 119.0 | 0.000612 | 228.0 | 13.5 | 18.5 |
| Idaho Chemical Processing Plant 23 | 12.3 | 0.025100 | 19.4 | 5.57 | 6.45 |
| Power Burst Facility 24 | 2.28 | 0.000026 | 0.027 | 9.2 | 0.71 |
| Power Burst Facility 25 | 10.2 | 0.000009 | 0.055 | 0.03 | 0.26 |
| Power Burst Facility 26 | 0.035 | 0.000008 | 0.011 | 0.001 | 0.23 |
| Power Burst Facility 27 | 10.9 | 0.000019 | 0.25 | 0.34 | 0.9 |
| Power Burst Facility 28 | 0.025 | 0.000006 | 0.018 | 0.01 | 0.17 |
| Radioactive Waste Management Complex 29 | 1.35 | 0.000016 | 0.073 | 0.44 | 0.41 |
| Test Reactor Area 30 | 21.1 | 0.000226 | 22.8 | 8.76 | 6.08 |
| Test Area North 31 | 7.68 | 0.000414 | 2.28 | 3.43 | 12.7 |
| Test Area North 32 | 5.78 | 0.000329 | 3.88 | 2.24 | 8.97 |
| Test Area North 33 | 0.85 | 0.000026 | 0.17 | 0.84 | 0.7 |

Source: IN DOE 1991e.

**TABLE B.1.3.2–3.—*Prevention of Significant Deterioration Sources and Concentration Increments Consumed at Idaho National Engineering Laboratory Boundary and Nearby Class I Area***

| Prevention of Significant Deterioration Source | | Prevention of Significant Deterioration Concentration | |
|---|---|---|---|
| **Description** | **Location** | **INEL Boundary** | **Craters of the Moon** |
| Coal-Fired Steam Generating Plant | Next to the Idaho Chemical Processing Plant | <10 percent of Class II allowable sulfur dioxide and total suspended particulates Prevention of Significant Deterioration increments | <20 percent of Class I allowable sulfur dioxide and total suspended particulates Prevention of Significant Deterioration increments |
| Fuel Processing Restoration Facility | Idaho Chemical Processing Plant | <1 percent of Class II allowable nitrogen dioxide and Prevention of Significant Deterioration increment | <1 percent of Class I allowable nitrogen dioxide and Prevention of Significant Deterioration increment |

Source: DOE 1992h; DOE 1992i; DOE 1992k.

**TABLE B.1.3.2–4.—*Emission Rates and Maximum Site Boundary Concentration of Toxic/Hazardous Air Pollutants at Idaho National Engineering Laboratory, 1990***

| Pollutant | Emission Rate (tons/yr) | Maximum 8-hour Average Concentration[a] ($\mu g/m^3$) | Proposed State of Idaho Ambient Concentration Limit[b] ($\mu g/m^3$) |
|---|---|---|---|
| Acetone | 0.01 | 0.3 | 17,800 |
| Ammonia | 3.0 | 30.0 | 180.0 |
| Nitric acid | 2.2 | 10.0 | 50.0 |
| 1,1,1-Trichloroethane | 1.0 | 0.2 | 19,100 |

[a] At U.S. 20/26, about 5 miles southwest of the New Production Reactor site proposed by DOE 1992a.

[b] 8-hour time-weighted average concentration, which is equal to one-hundredth of the occupational exposure level. These are ambient concentration limits proposed for use as one of the criteria in evaluating a construction permit application for a new source.

Source: DOE 1992h; DOE 1992i; DOE 1992k.

**TABLE B.1.3.2–5.—*Estimated Ambient Concentration of Criteria Pollutants from Baseline Sources at Idaho National Engineering Laboratory, 1990***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Maximum Background Concentrations[a] ($\mu g/m^3$) | INEL Contribution Concentration[a] ($\mu g/m^3$) | Baseline Concentration[a] ($\mu g/m^3$) |
|---|---|---|---|---|---|
| Carbon monoxide | 8-hour | 10,000 | [b] | 6 | 6 |
| | 1-hour | 40,000 | [b] | 21 | 21 |
| Lead | Calendar Quarter | 1.5 | [b] | [b] | [c] |
| Nitrogen dioxide | Annual | 100 | 5 | 3 | 8 |
| Ozone | 1-hour | 235 | [b] | [b] | [b] |
| Particulate matter | Annual | 50 | 14 | 0.3 | 14.3 |
| | 24-hour | 150 | 32 | 2.5 | 34.5 |
| Sulfur dioxide | Annual | 80 | 0.2 | 4 | 4.2 |
| | 24-hour | 365 | 8 | 38 | 46 |
| | 3-hour | 1,300 | 14 | 120 | 134 |
| Total suspended particulates | Annual | 60 | 40 | 0.3 | 40.3 |
| | 24-hour | 150 | 88 | 3 | 91 |

[a] The concentrations are maximum values; all maximum concentrations occur on U.S. 20/26.

[b] Not modeled due to negligible emission rate.

Source: 40 CFR 50; DOE 1992h; DOE 1992i; DOE 1992k; IN DHW 1992b.

### B.1.3.3 *Nevada Test Site*

This section provides information on meteorology and climatology, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figure B.1.3.3–1) at the Nevada Test Site (NTS). Air quality monitoring data, emission source inventories for criteria pollutants, and estimated ambient concentrations of criteria pollutants from existing sources at NTS are presented in tables B.1.3.3–1, B.1.3.3–2, and B.1.3.3–3, respectively. This information supports data presented in section 4.3.2.3.

**Meteorology and Climatology**. Figure B.1.3.3–1 shows annual wind direction frequencies and mean wind speeds for 1990 measured at the 33-foot level of Desert Rock National Weather Service station near NTS. Overall, predominating winds are southerly during summer and northerly during winter. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north to south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime associated with large-scale pressure systems.

Average annual wind speeds and direction vary with location. At higher elevations on Pahute Mesa, the average annual wind speed is 10.5 mph. The prevailing wind direction during winter months is north-northeasterly, and during summer months, winds are southerly. In Yucca Flat the average annual wind speed is 7 mph. The prevailing wind direction during winter months is north-northwesterly and during summer months is south-southwesterly. At Mercury, NV, the average annual wind speed is 8 mph, with northwesterly prevailing winds during the winter months and southwesterly winds during the summer months.

Elevation influences temperatures on NTS. At an elevation of 6,560 feet above MSL on Pahute Mesa, the average daily maximum/minimum temperatures are 40 °F/28 °F in January and 80 °F/62 °F in July. In Yucca Flat, 3,920 feet MSL, the average daily maximum/minimum temperatures are 51 °F/21 °F in January and 96 °F/57 °F in July. The extreme temperatures at Mercury are 69 °F/12 °F in January and 109 °F/59 °F in July.

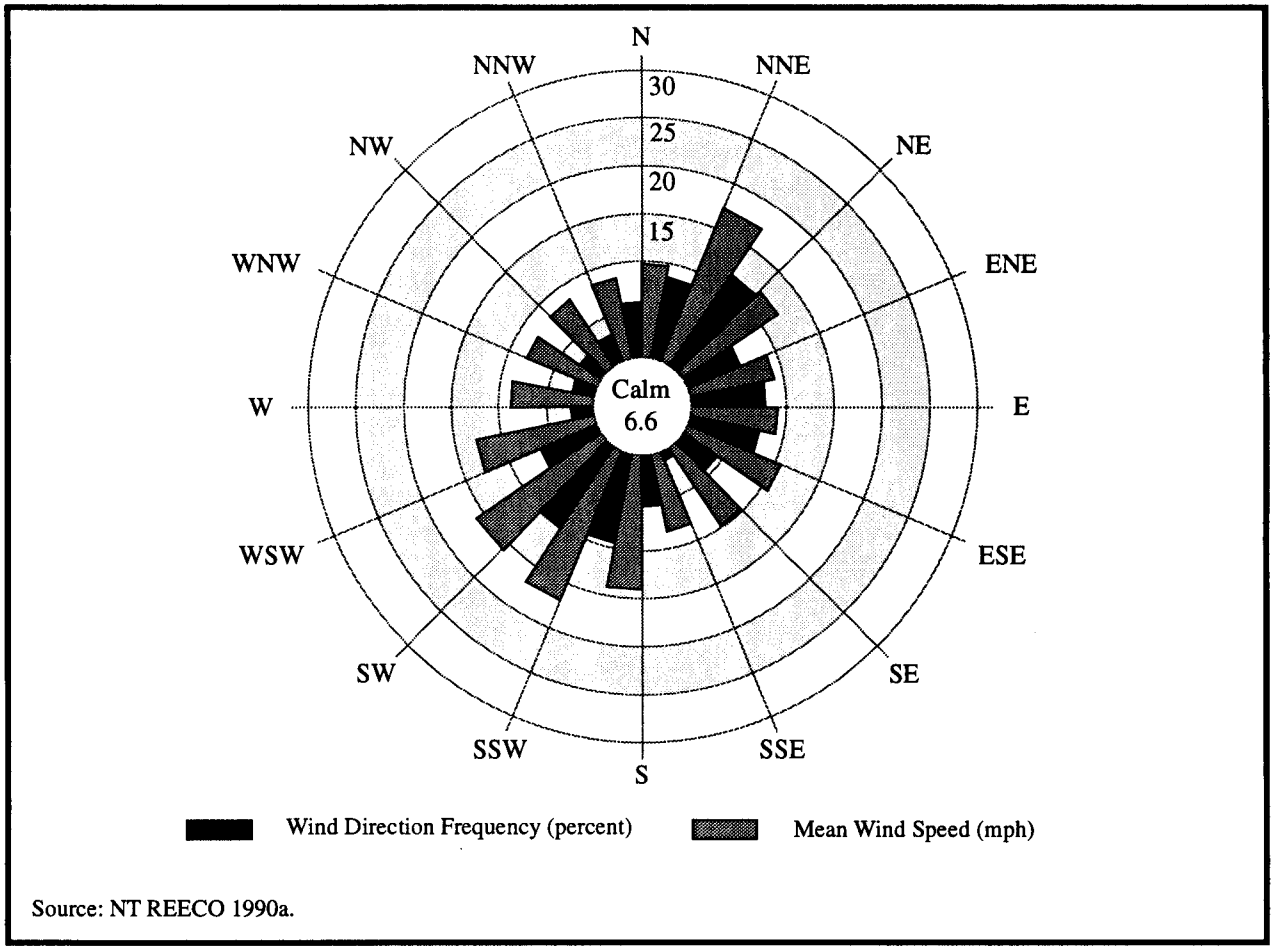
The annual average temperature in the NTS area is 66.3 °F (NOAA 1991d). Monthly average temperatures range from 44.5 °F in January to 89.8 °F in July. Relative humidity readings taken 4 times per day range from 11 percent in June to 55 percent in January and December.

Annual precipitation in southern Nevada is very light and depends largely upon elevation. On NTS, the mesas receive an average annual precipitation of 9 inches, which includes winter snow accumulations. The lower elevations receive approximately 6 inches of precipitation annually, with occasional snow accumulations lasting only a few days (NT DOC 1968a).

Precipitation usually falls in isolated showers with large variations in precipitation amounts within a shower area. Summer precipitation occurs mainly in July and August when intense heating of the ground below moist air masses triggers thunderstorm development. On rare occasions, a tropical storm will move northeastward from the coast of Mexico, bringing heavy precipitation during August and/or September.

Wind speeds in excess of 60 mph, with gusts up to 107 mph may be expected to occur on a 100-year return period (NT DOC 1968a). Other than temperature extremes, severe weather in the region includes occasional thunderstorms, lightning, tornadoes, and sandstorms. Severe thunderstorms may produce high precipitation with durations of approximately one hour, and may create a potential for flash flooding (NT DOE 1983a). Tornadoes have been observed in the region but are infrequent. The estimated probability of a tornado striking a point at NTS is $3.0 \times 10^{-7}$ per year (NRC 1986a).

**Atmospheric Dispersion Characteristics.** Data collected for calendar year 1990 indicate that unstable conditions occur approximately 25 percent of the time, neutral conditions approximately 38 percent, and stable conditions approximately 37 percent, on an annual basis.




Source: NT REECO 1990a.

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**FIGURE B.1.3.3–1.—*Wind Distribution at Nevada Test Site, 1990 (33-foot level).***

**TABLE B.1.3.3–1.—*Ambient Air Quality Data for Nevada Test Site, 1990***

| | | Ambient Concentration (μg/m³) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Time Period | Sulfur Dioxide | | | Carbon Monoxide | | Particulate Matter[a] | |
| Monitoring Station | | Annual | Max. 24-hour | Max. 3-hour | Max. 8-hour | Max. 1-hour | Annual | Max. 24-hour |
| Area 6 | Aug.15, 1990-Sep. 15, 1990 | [b] | 0 | 0 | 1,145 | 1,947 | [b] | 20.2 |
| Area 12 | Aug.15, 1990-Sep. 15, 1990 | [b] | 15.7 | 52.4 | 2,290 | 2,748 | [b] | 45.4 |
| Area 23 | Aug. 15, 1990-Sep. 15, 1990 | [b] | 39.3 | 65.4 | 1,374 | 1,374 | [b] | 78.3 |

[a] Particulate matter less than 10 μm in diameter.
[b] Not measured.
Note: Nitrogen oxide, lead, and ozone were not measured at this site.
Source: NT REECO 1990a.

**TABLE B.1.3.3–2.—*Source Emission Inventory for Nevada Test Site, 1992***

| Source | Criteria Pollutant—Emission Rate (lb/hr) | |
|---|---|---|
| | Particulate Matter | Sulfur Dioxide |
| Area 1 Rotary Dryer | 7.1 | NA |
| Area 6 Boiler | 2.9 | 2.5 |
| Area 12 Boiler | 2.8 | 2.8 |
| Area 23 Boiler | 3.1 | 3.6 |
| Area 23 Boiler | 2.8 | 2.8 |
| Area 23 Incinerator | 0.75 | 3.0 |

Note: NA - not applicable.
Source: NT DCNR 1992a.

**TABLE B.1.3.3–3.—*Estimated Ambient Concentration of Criteria Pollutants from Existing Sources at Nevada Test Site, 1990***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Maximum Background Concentrations ($\mu g/m^3$) | NTS Contribution Concentration ($\mu g/m^3$) | Baseline Concentration ($\mu g/m^3$) |
|---|---|---|---|---|---|
| Carbon monoxide | 8-hour | 10,000 | 2,290 | [a] | 2,290 |
| | 1-hour | 40,000 | 2,748 | [a] | 2,748 |
| Lead | Quarter | 1.5 | [b] | [a] | [a] |
| Nitrogen dioxide | Annual | 100 | [b] | [a] | [a] |
| Ozone | 1-hour | 235 | [b] | [b] | [b] |
| Particulate matter | Annual | 50 | [b] | 8.39 | 8.39 |
| | 24-hour | 150 | 78.3 | 94.3 | 172.6 |
| Sulfur dioxide | Annual | 80 | [b] | 6.9 | 6.9 |
| | 24-hour | 365 | 39.3 | 77.7 | 117.0 |
| | 3-hour | 1,300 | 65.4 | 595.2 | 660.6 |

[a] No sources indicated.
[b] Not monitored.
Note: Monitoring data based on 1 month of sampling from August 15 to September 15, 1990.
Source: NT REECO 1990a.

### B.1.3.4 *Oak Ridge Reservation*

This section provides information on meteorology and climatology, atmospheric dispersion characteristics, annual mean wind speeds and direction frequencies (figure B.1.3.4–1), and locations of ambient air quality monitoring stations (figure B.1.3.4–2) at the Oak Ridge Reservation (ORR). Tables B.1.3.4–1 and B.1.3.4–2, respectively, present air quality monitoring data and emission source inventories for criteria pollutants at ORR. Tables B.1.3.4–3 and B.1.3.4–4, respectively, present emission rates and maximum site boundary or public access highways within the site boundary concentrations of toxic/hazardous air pollutants and estimated ambient concentrations of criteria pollutants from existing sources at ORR. This information supports data presented in section 4.4.2.3.

**Meteorology and Climatology.** The wind direction above the ridge tops and within the valley at ORR tends to follow the orientation of the valley. On an annual basis, the prevailing winds at the National Weather Service station in the city of Oak Ridge are either up-valley, from west to southwest, or down-valley, from east to northeast. Figure B.1.3.4–1 shows annual wind direction frequencies and mean wind speeds for 1990 measured at the 98-foot level of the ORR meteorology tower. The prevailing wind directions are from the southwest and northeast quadrants. Mean annual wind speeds measured in the region are relatively low averaging 4.5 mph at the National Weather Service station at the 46-foot level and 4.7 mph at the 33-foot level at the ORR Bethel Valley monitoring station.

The annual average temperature at ORR is 57.5 °F; temperatures vary from an average daily minimum of 27.7 °F in January to an average daily maximum of 87.2 °F in July. Relative humidity readings taken 4 times per day range from 51 percent in April to 92 percent in August and September (NOAA 1991c).

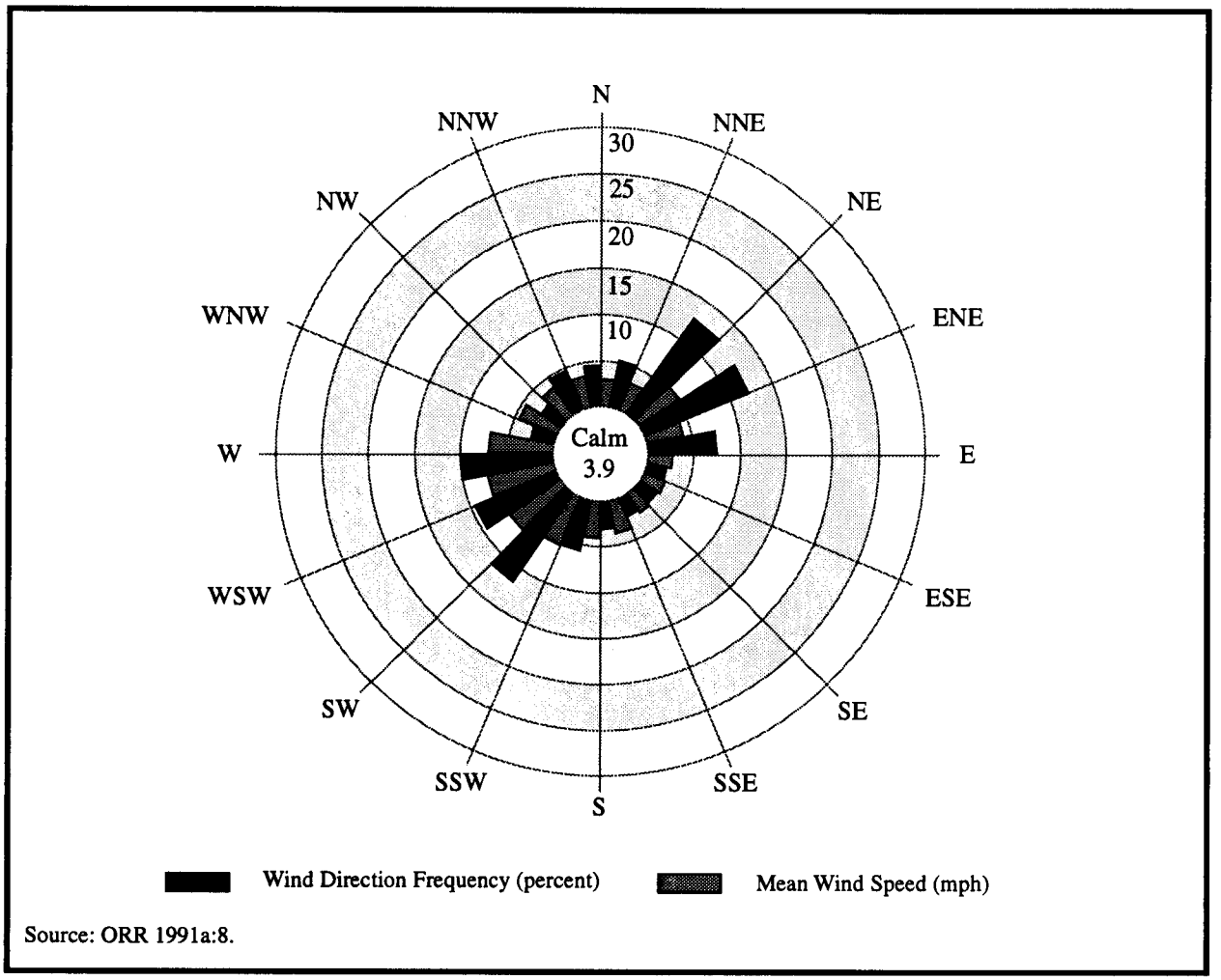
The average annual precipitation measured at ORR in Bethel Valley is 51.5 inches, while the average annual precipitation for the National Weather Service station in Oak Ridge is 54.0 inches. The maximum monthly precipitation recorded at the National Weather Service station was 19.3 inches in July 1967, while the maximum rainfall in a 24-hour period observed at the Oak Ridge National Weather Service station was recorded in August 1960 at 7.5 inches. The average annual snowfall as measured at the Oak Ridge National Weather Service station is 10.1 inches.

Damaging winds are uncommon in the region. Peak gusts recorded in the area range from 60 to 69 mph for the months of January through July; from 49 to 60 mph for August, September, and December; and 36 to 45 mph in October and November (ORNL 1982a). The fastest mile wind speed (the 1 mile passage of wind with the highest speed for the day) recorded at the Oak Ridge National Weather Service station for the period of record 1958 through 1979 was 59.1 mph in January 1959.

The extreme mile wind speed at 30 feet that is predicted to occur near ORR once in 100 years is approximately 90 mph. The approximate values for occurrence intervals of 10, 25, and 50 years are 65, 74, and 76 mph, respectively.

Between 1916 and 1972, there were 25 tornadoes reported in the counties of Tennessee having borders within about 40 miles of ORR (ORNL 1981a). The probability of a tornado striking a particular point in the vicinity of ORR is estimated to be $6.0 \times 10^{-5}$ per year. The recurrence interval associated with this probability is 16,550 years (ORNL 1981a).

**Atmospheric Dispersion Characteristics.** Data collected at the ORR meteorological monitoring station (Y-12 Plant east tower) for calendar year 1990 indicate that unstable conditions occur approximately 23 percent of the time, neutral conditions approximately 31 percent, and stable conditions approximately 46 percent, on an annual basis.




Source: ORR 1991a:8.

2039

**FIGURE B.1.3.4–1.—*Wind Distribution at Oak Ridge Reservation, 1990 (98-foot level).***

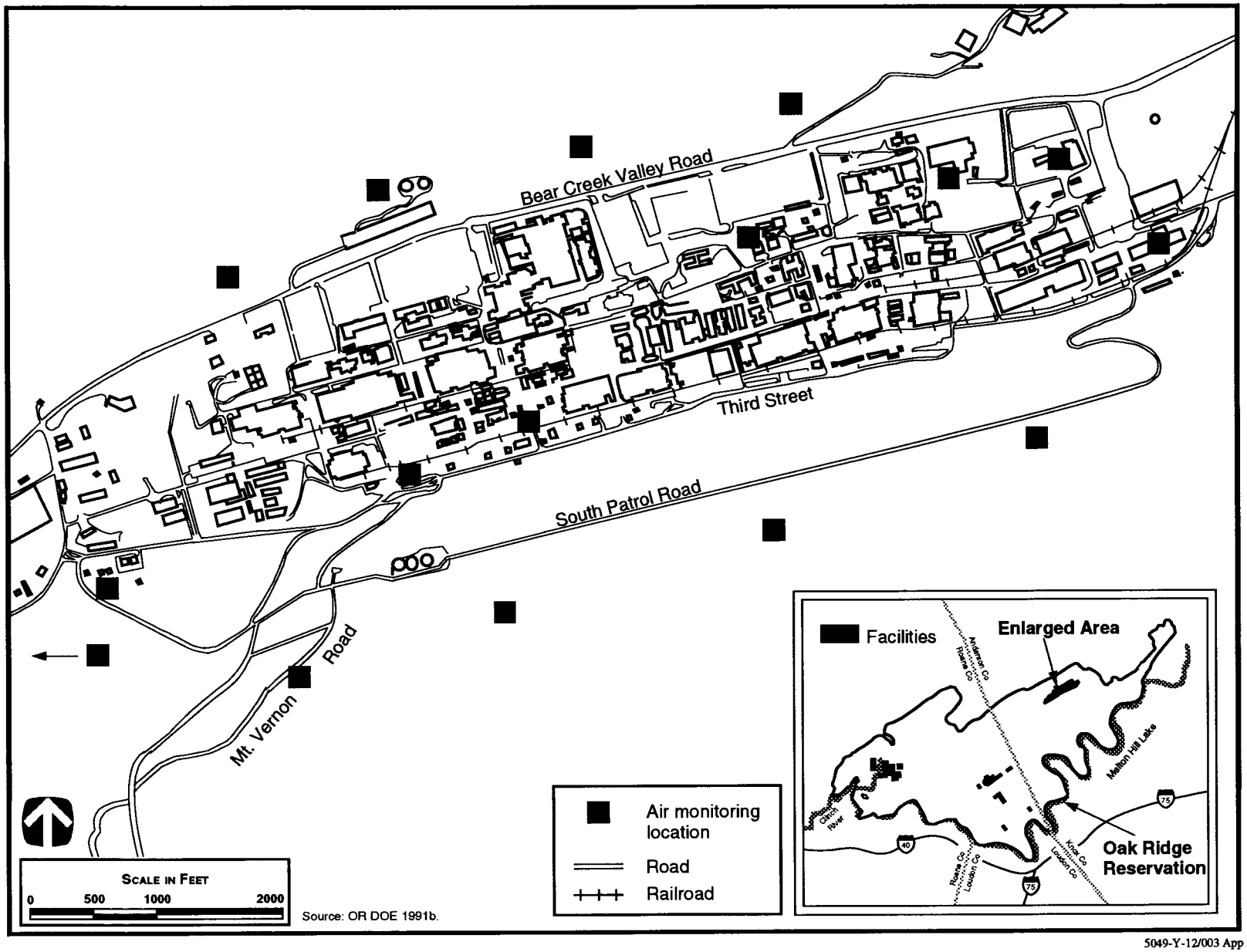



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**FIGURE B.1.3.4–2.**—*Air Monitoring Stations at Oak Ridge Reservation, Y-12 Plant.*

**TABLE B.1.3.4–1.—*Ambient Air Quality Data for Oak Ridge Reservation, 1990***

| Monitoring Station | Ambient Concentration (μg/m³) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sulfur Dioxide | | | Carbon Monoxide | | Nitrogen Oxides | Total Suspended Particulates[a] | | Particulate Matter[b,c] | | Lead[c] | Fluoride[c] | |
| | Annual | Max. 24-hour | Max. 3-hour | Max. 8-hour | Max. 1-hour | Annual | Annual | Max. 24-hour | Annual | Max. 24-hour | Max. Calendar Quarter | Max. 30-day | Max. 7-day |
| Oak Ridge Reservation | 27 | 73 | 321 | [d] | [d] | [d] | 32 | 73 | 8 | 54 | 0.05[e] | 0.06 | 0.03 |

[a] Excludes low air flow measurements.
[b] Particulate matter less than 10 microns in diameter.
[c] Monitoring station is at K-25.
[d] Not monitored.
[e] Value is maximum for a 24-hour period.
Source: OR DOE 1991b; OR DOE 1991d.

**TABLE B.1.3.4–2.—*Source Emission Inventory for Oak Ridge Reservation, 1990-1992***

| Source | Criteria Pollutant—Emission Rate (lb/hr) | | | |
|---|---|---|---|---|
| | Carbon Monoxide | Nitrogen Oxide | Particulate Matter | Sulfur Dioxide |
| Y–9401 West Stack | 4.63 | 81.65 | 0.20 | 33.84 |
| Y–9401 East Stack | 4.63 | 81.65 | 0.20 | 33.84 |
| K-1501 Boiler 4 | 0.61 | 2.46 | 0.09 | 0.01 |
| K-1501 Boiler 7 | 0.46 | 1.84 | 0.07 | 0.008 |
| K-1501 Boiler 8 and 9 | 1.97 | 0.74 | 0.13 | 0.008 |
| K-25 Toxic Substance Control Act Incinerator | | | 2.06 | 0.58 |
| X-2519-1 | 9.84 | 27.56 | 1.19 | 176.59 |
| X-2519-2 | 1.68 | 27.56 | 1.19 | 176.59 |
| X-2519-3 and 4 | | | 0.32 | 0.075 |

Source: OR DOE 1993a.

**TABLE B.1.3.4–3.—*Emission Rates and Maximum Site Boundary Concentration of Toxic/Hazardous Air Pollutants at Oak Ridge Reservation, 1992***

| Pollutant | Emission Rate (tons/yr) | Maximum 8-hour Average Concentration[a] ($\mu g/m^3$) | Tennessee Department of Health and Environment Standard ($\mu g/m^3$) |
|---|---|---|---|
| Chlorine | 1.82 | 4.1 | 150 |
| Chlorodifluoromethane | 3.85 | 16.4 | 354,000 |
| Dichlorodifluoromethane | 3.37 | 10.5 | 495,000 |
| Dichlorotetrafluoroethane | 10.04 | 24.1 | 699,000 |
| Hydrochloric acid | 7.72 | 57 | 750 |
| Methyl alcohol | 29.11 | 216 | 26,200 |
| Nitric acid | 10.5 | 78 | 520 |
| Sulfuric acid | 2.71 | 20 | 100 |
| Tetrachloroethylene | 13.5 | 100 | 33,900 |
| Trichloroethane | 0.82 | 6.1 | 191,000 |
| Trichlorofluoromethane | 8.80 | 46.2 | 562,000 |
| Trichlorotrifluoroethane | 3.02 | 10.1 | 767,000 |

[a] The concentrations are the maximum values at or beyond the site boundary or on public access highways.
Source: OR DOE 1993a.

**TABLE B.1.3.4–4.—*Estimated Ambient Concentration of Criteria Pollutants from Existing Sources at Oak Ridge Reservation, 1992***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Maximum Background Concentration[a] ($\mu g/m^3$) | ORR Contribution Concentration[a] ($\mu g/m^3$) | Baseline Concentration[a] ($\mu g/m^3$) |
|---|---|---|---|---|---|
| Carbon monoxide | 8-hour | 10,000 | [b] | 5 | 5 |
| | 1-hour | 40,000 | [b] | 11 | 11 |
| Lead | Calendar Quarter | 1.5 | 0.05 | [c] | 0.05 |
| Nitrogen dioxide | Annual | 100 | [b] | 3 | 3 |
| Particulate matter | Annual | 50 | 8 | <1 | 9 |
| | 24-hour | 150 | 54 | 2 | 56 |
| Sulfur dioxide | Annual | 80 | 27 | 2 | 29 |
| | 24-hour | 365 | 73 | 32 | 105 |
| | 3-hour | 1,300 | 321 | 80 | 401 |
| Total suspended particulates | Annual | 50 | 32 | <1 | 33 |
| | 24-hour | 150 | 73 | 2 | 75 |

[a] The concentrations are the maximum values at or beyond the site boundary or on public access highways.
[b] Not monitored.
[c] No source indicated.
Source: OR DOE 1993a.

### B.1.3.5 *Pantex Plant*

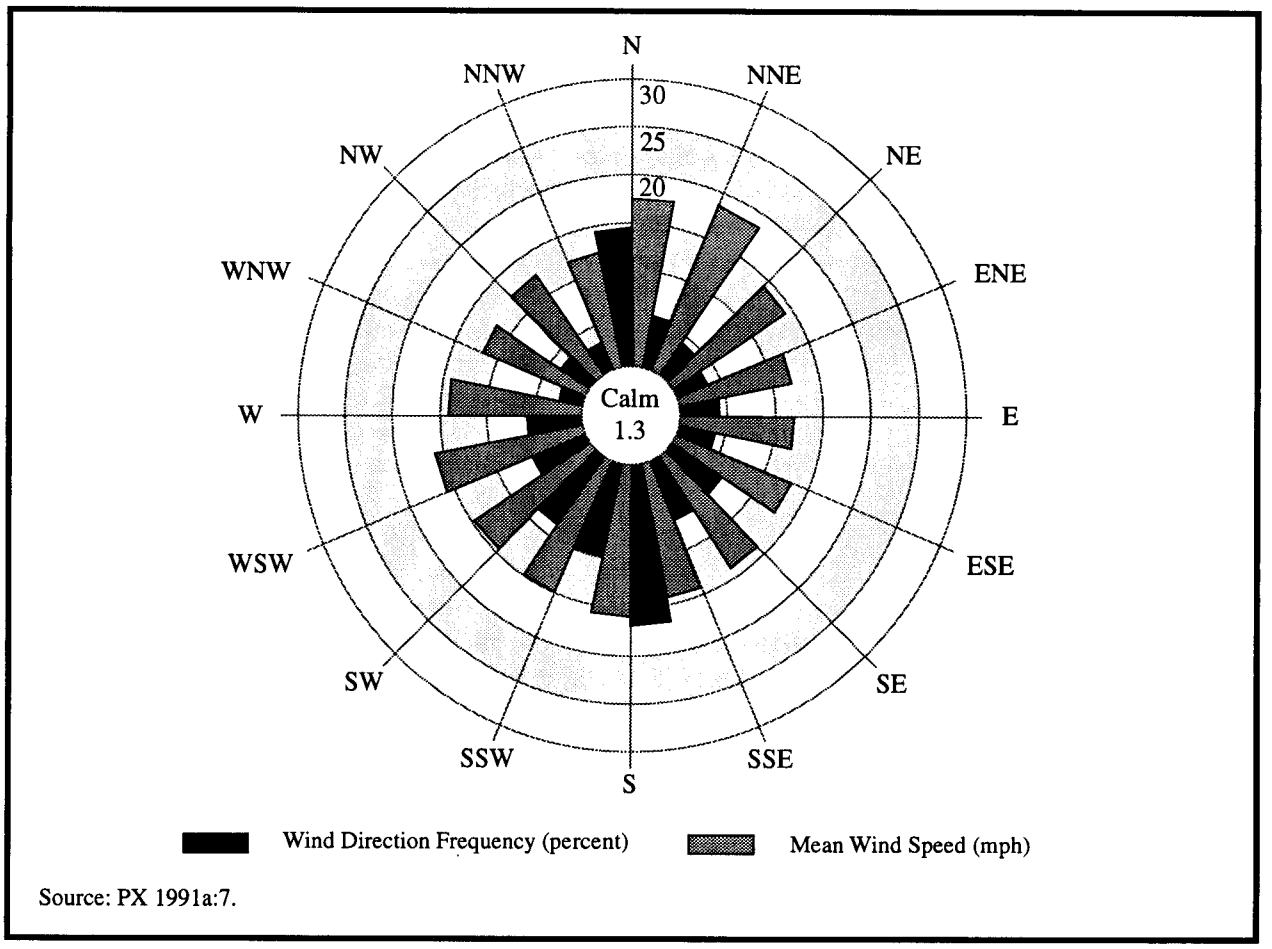
This section provides information on meteorology and climatology, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figure B.1.3.5–1) at Pantex. Tables B.1.3.5–1 and B.1.3.5–2, respectively, present air quality monitoring data and emission source inventories for criteria pollutants at Pantex. Tables B.1.3.5–3 and B.1.3.5–4, respectively, present emission rates and maximum site boundary concentrations of toxic/hazardous air pollutants and estimated ambient concentrations of criteria pollutants from existing sources at Pantex. This information supports data presented in section 4.5.2.3.

**Meteorology and Climatology.** Figure B.1.3.5–1 shows annual wind direction frequencies and mean wind speeds for 1989 measured at the 33-foot level of the Amarillo National Weather Service station near Pantex. Prevailing wind directions are from the south to southwest. The annual average wind speed measured at the Amarillo National Weather Service station is 13.6 mph. Monthly average wind speeds range from 12.0 mph in August to 15.4 mph in March (NOAA 1991c).

The annual average temperature in the Amarillo region is about 57 °F, and ranges from an average of 36 °F in January to about 78 °F in July. Relative humidity readings taken 4 times per day range from 31 percent in April to 80 percent in September (NOAA 1991c).

The average annual precipitation in Amarillo is 19.1 inches (NOAA 1991c). Most of the annual precipitation falls during the months of April through October and usually occurs from thunderstorm activity and the intrusion of warm, moist tropical air from the Gulf of Mexico. Snowfall averages nearly 15.5 inches. Snowfall has occurred in the area from October to April.The maximum 24-hour rainfall with a 100-year recurrence interval is approximately 6.5 inches. On the average, the area can expect thunderstorms about 50 days per year, hail 4 days per year, and freezing rain 8 days per year. During the 30-year period between 1954 and 1983, a total of 107 tornadoes were reported within a 1-degree latitude and longitude square area which includes Pantex. On average, less than four tornadoes occur in an area of 3,898 square miles surrounding Pantex per year. The estimated probability of a tornado striking a point at Pantex is $2.3 \times 10^{-4}$ per year (NRC 1986a).

**Atmospheric Dispersion Characteristics.** Data collected at the Amarillo National Weather Service station for 1989 indicate that unstable conditions occur approximately 16 percent of the time, neutral conditions approximately 60 percent, and stable conditions approximately 24 percent, on an annual basis.




Source: PX 1991a:7.

**FIGURE B.1.3.5–1.—*Wind Distribution at Pantex Plant, 1989 (33-foot level).*** 2036

**TABLE B.1.3.5–1.—*Ambient Air Quality Data for Pantex Plant, 1986–1991***

| Monitoring Station | Time Period | Ambient Concentration (μg/m³) | | |
|---|---|---|---|---|
| | | Particulate Matter[a] | | Lead |
| | | Annual | Maximum 24-hour | Maximum Calendar Quarter |
| Bi-City-County Health Unit 417, Amarillo | Jan. 1986-Apr. 1987 | [b] | [b] | 0.07 |
| Bi-City-County Health Unit 417, Amarillo | Jan. 1986-Dec. 1988 | 26.5[c] | 67 | [b] |
| Van Buren and 4th St., Amarillo | Jan. 1990-Dec. 1991 | 21.4[c] | 110 | [b] |

[a] Particulate matter less than 10 microns in diameter.
[b] Not measured.
[c] Indicates that the mean does not satisfy summary criteria.
Source: PX EPA 1992a.

**TABLE B.1.3.5–2.—*Source Emission Inventory for Pantex Plant, 1991***

| Source | Air Pollutant – Emission Rate (lb/hr) | | | | |
|---|---|---|---|---|---|
| | Carbon Monoxide | Hydrogen Fluoride | Nitrogen Oxide | Particulate Matter | Sulfur Dioxide |
| Buildings | 3.72 | | 0.43 | 0.25 | 0.07 |
| Natural gas boilers | 1.77 | | 7.10 | 0.25 | 0.06 |
| Natural gas furnaces | 0.13 | | 0.67 | 0.02 | |
| Natural gas water heaters | 0.06 | | 0.28 | 0.01 | |
| Natural gas engines | 2.38 | | 18.46 | | |
| Emergency electric generators | 6.40 | | 36.00 | 0.40 | 2.20 |
| Diesel engines | 82.64 | | 352.23 | 25.15 | 23.43 |
| Burning of high explosive wastes | 4.38 | | 0.21 | 2.42 | |
| Burning of high explosives | 15.40 | 5.89 | 9.31 | | |
| Gasoline engines | 44.39 | | 1.15 | 0.07 | 0.07 |

Source: PX 1992a:9.

**TABLE B.1.3.5–3.—*Emission Rates and Maximum Site Boundary Concentration of Toxic/Hazardous Air Pollutants at Pantex Plant, 1991***

| Pollutant | Emission Rate (tons/yr) | Max. 1-hour Concentration[a] ($\mu g/m^3$) | Annual Average Concentration ($\mu g/m^3$) | Texas Air Control Board | |
|---|---|---|---|---|---|
| | | | | 30-minute Standard ($\mu g/m^3$) | Annual Standard ($\mu g/m^3$) |
| Acetone | 6.82 | 341.1 | 0.2 | 5,900 | 590 |
| Aliphatic hydrocarbons | 0.11 | 19.0 | <0.01 | d | d |
| Aromatic hydrocarbons | 0.15 | 27.2 | <0.01 | d | d |
| Aromatic petroleum distillate | 0.08 | 13.6 | <0.01 | 3,500 | 350 |
| 2-Butoxyethanol | 4.47 | 208.9 | 0.13 | 1,210 | 121 |
| Butyl acetate[b] | 0.48 | 87.0 | 0.01 | 1,850 | 710 |
| Butyl alcohol[c] | 0.18 | 31.6 | 0.01 | 1,220 | 150 |
| Chlorodifluoromethane | 0.10 | 4.9 | <0.01 | 18,000 | 1,800 |
| Cyanogen | 0.26 | 161.8 | 0.01 | 210 | 21 |
| Dichlorodifluoromethane | 0.15 | 23.2 | <0.01 | 49,500 | 4,950 |
| Diesel fuel | 0.05 | 2.4 | <0.01 | 90 | 9 |
| Ethyl alcohol | 0.12 | 12.2 | <0.01 | 18,800 | 1,880 |
| Epoxy solvent | 0.09 | 16.5 | <0.01 | d | d |
| Freon TF | 0.53 | 24.8 | 0.02 | d | d |
| Hydrocarbons | 2.75 | 1,812 | 0.08 | d | d |
| Hydrogen chloride | 0.37 | 232.3 | 0.01 | 75 | 0.1 |
| Isopropyl alcohol | 0.74 | 127.3 | 0.02 | 7,856 | 980 |
| Methyl ethyl ketone | 0.53 | 92.8 | 0.02 | 3,900 | 590 |
| Methyl alcohol | 3.80 | 178.3 | 0.11 | 2,620 | 262 |
| Methyl isobutyl ketone | 0.06 | 5.4 | <0.01 | 2,050 | 205 |
| Tert-butyl-ether | 0.18 | 1.9 | 0.01 | d | d |
| Tetrahydrofuran | 0.63 | 29.6 | 0.02 | 5,900 | 590 |
| Toluene | 4.41 | 236.2 | 0.13 | 3,750 | 375 |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane | 0.11 | 12.6 | <0.01 | d | d |
| 1,1,1-Trichloroethane | 0.075 | 8.3 | <0.01 | 19,100 | 1,910 |
| Trichlorotrifluoroethane | 0.14 | 7.3 | <0.01 | 10,000 | 1,000 |
| VM&P naptha | 0.13 | 23.3 | <0.01 | 3,500 | 350 |
| Xylene | 0.09 | 44.2 | <0.01 | 3,700 | 435 |

[a] 30-minute concentrations calculated as 1-hour concentrations.

[b] Assumed to be butyl acetate, n-

[c] Assumed to be butyl alcohol, n-

[d] No state standards.

Source: PX 1991a:10; PX ACB 1991a.

**TABLE B.1.3.5–4.—*Estimated Ambient Concentration of Pollutants from Existing Sources at Pantex Plant, 1991***

| Pollutant | Averaging Time | Most Stringent Regulation or Guideline ($\mu g/m^3$) | Maximum Background Concentration[a] ($\mu g/m^3$) | Pantex Plant Contribution Concentration[a] ($\mu g/m^3$) | Baseline Concentration[a] ($\mu g/m^3$) |
|---|---|---|---|---|---|
| **Criteria Pollutant** | | | | | |
| Carbon monoxide | 8-hour | 10,000 | b | 1,352 | 1,352 |
| | 1-hour | 40,000 | b | 7,836 | 7,836 |
| Lead | Quarter | 1.5 | 0.07 | c | 0.07 |
| Nitrogen dioxide | Annual | 100 | b | 2 | 2 |
| Ozone | 1-hour | 235 | b | b | b |
| Particulate matter | Annual | 50 | 26.5 | 0.07 | 27 |
| | 24-hour | 150 | 110.0 | 4.35 | 114 |
| Sulfur dioxide | Annual | 80 | b | 0.03 | 0.03 |
| | 24-hour | 365 | b | 24.33 | 24 |
| | 3-hour | 1,300 | b | 194.41 | 194 |
| **Mandated by Texas** | | | | | |
| Beryllium | 24-hour | 0.01 | b | c | c |
| Hydrofluoric acid | 30-day | 0.8 | b | c | c |
| | 7-day | 1.6 | b | c | c |
| | 24-hour | 2.9 | b | c | c |
| | 12-hour | 3.7 | b | c | c |

[a] The concentrations are the maximum values at or beyond the site boundary.
[b] Not monitored.
[c] No source indicated.
Source: PX 1992a:9; PX EPA 1992a.

### B.1.3.6 *Savannah River Site*

This section provides information on meteorology and climatology, atmospheric dispersion characteristics, annual mean wind speeds and direction frequencies (figure B.1.3.6–1), and locations of ambient air quality monitoring stations (figure B.1.3.6–2) at the Savannah River Site (SRS). Tables B.1.3.6–1 and B.1.3.6–2, respectively, present air quality monitoring data and emission source inventories for criteria pollutants at SRS. Tables B.1.3.6–3 and B.1.3.6–4, respectively, present emission rates and maximum site boundary concentrations of toxic/hazardous air pollutants and estimated ambient concentrations of criteria pollutants from existing sources at SRS. This information supports data presented in section 4.6.2.3.

**Meteorology and Climatology.** Figure B.1.3.6–1 shows annual wind direction frequencies and wind speeds for 1985 measured at the 200-foot level of the SRS H-Area Weather Station. The wind data from the site indicate that there is no predominant wind direction at SRS. The maximum directional frequencies are from the northeast or the west. The annual average wind speed measured is 12.8 mph. Monthly average wind speeds range from 11.2 mph from June through August, to 15.1 mph in February.

The annual average temperature at SRS is 64 °F; monthly averages range from 45 °F in January to 81 °F in July. Relative humidity readings taken 4 times per day range from 36 percent in April to 98 percent in August.

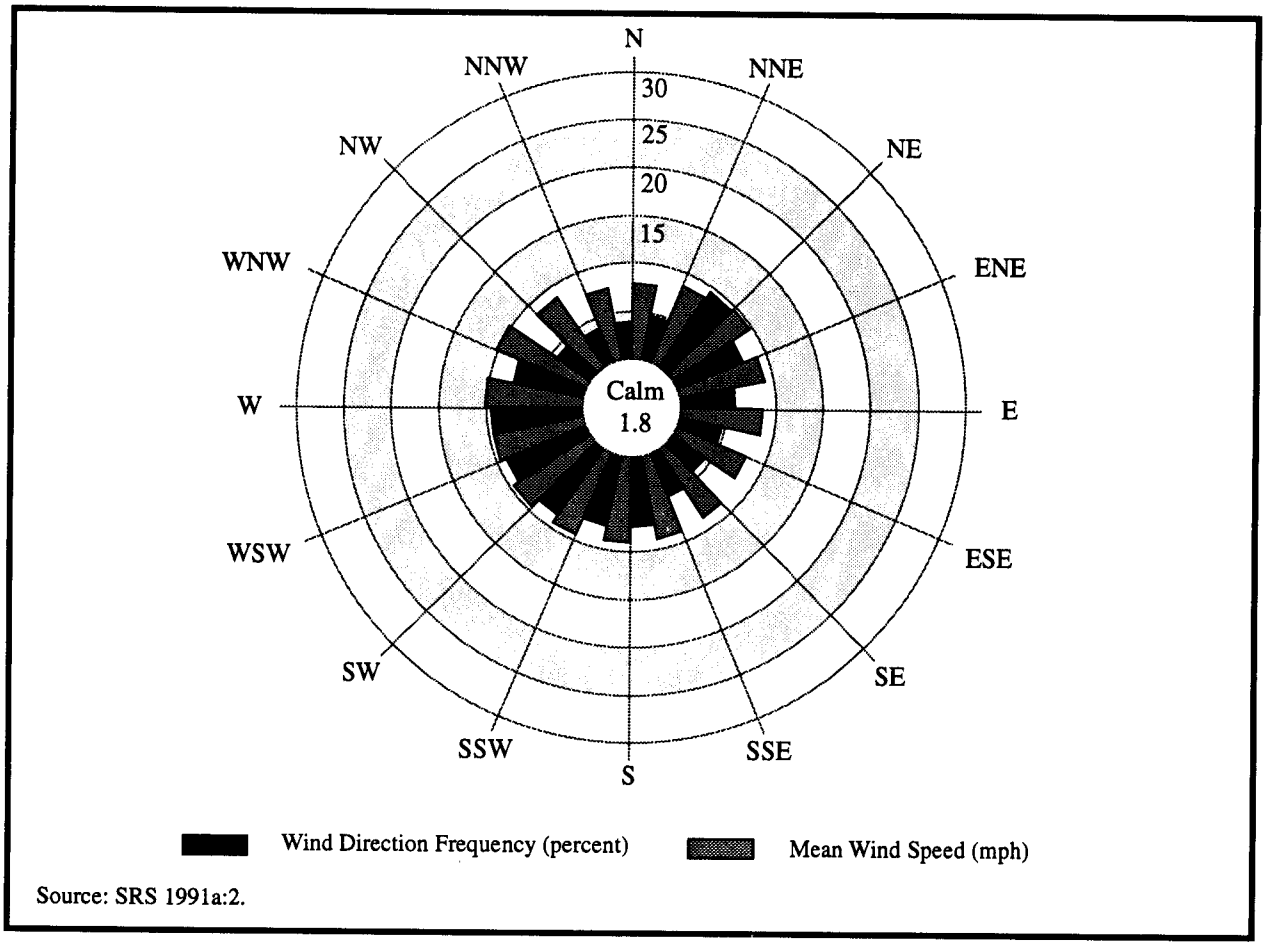
The average annual precipitation at SRS is 48 inches. Precipitation is distributed fairly evenly throughout the year, with the highest precipitation in summer (14.2 inches) and the lowest in autumn (8.8 inches). Although snow can fall from October through March, the average annual snowfall is only 1.2 inches; large snowfalls are rare.

Winter storms in the SRS area occasionally bring strong and gusty surface winds with speeds as high as 72 mph. Thunderstorms can generate winds with speeds as high as 40 mph and even stronger gusts. The fastest 1-minute wind speed recorded at Augusta between 1950 and 1986 was 83 mph (NOAA 1991c).

The average number of thunderstorm days per year at SRS is 56. From 1954 to 1983, 37 tornadoes were reported for a 1-degree square of latitude and longitude that includes SRS. This frequency of occurrence amounts to an average of about one tornado per year. The estimated probability of a tornado striking a point at SRS is $7 \times 10^{-5}$ per year (NRC 1986a). Since operations began at SRS in 1953, six tornadoes have been confirmed on or near SRS. Nothing more than light damage was reported in any of these storms, with the exception of a tornado in October 1989. That tornado caused considerable damage to timber resources in an undeveloped wooded area of SRS (WSRC 1990a).

From 1899 to 1980, 13 hurricanes occurred in Georgia and South Carolina, for an average frequency of about one hurricane every 6 years. Three hurricanes were classified as major. Because SRS is about 100 miles inland, the winds associated with hurricanes have usually diminished below hurricane force (greater than or equal to a sustained speed of 75 mph) before reaching the site (DOE 1991c).

**Atmospheric Dispersion Characteristics.** Data collected at the SRS meteorological monitoring station for 1985 indicate that unstable conditions occur approximately 51 percent of the time, neutral conditions approximately 27 percent of the time, and stable conditions approximately 22 percent of the time, on an annual basis.




Source: SRS 1991a:2.

**FIGURE B.1.3.6–1.—*Wind Distribution at Savannah River Site, 1985 (200-foot level).***

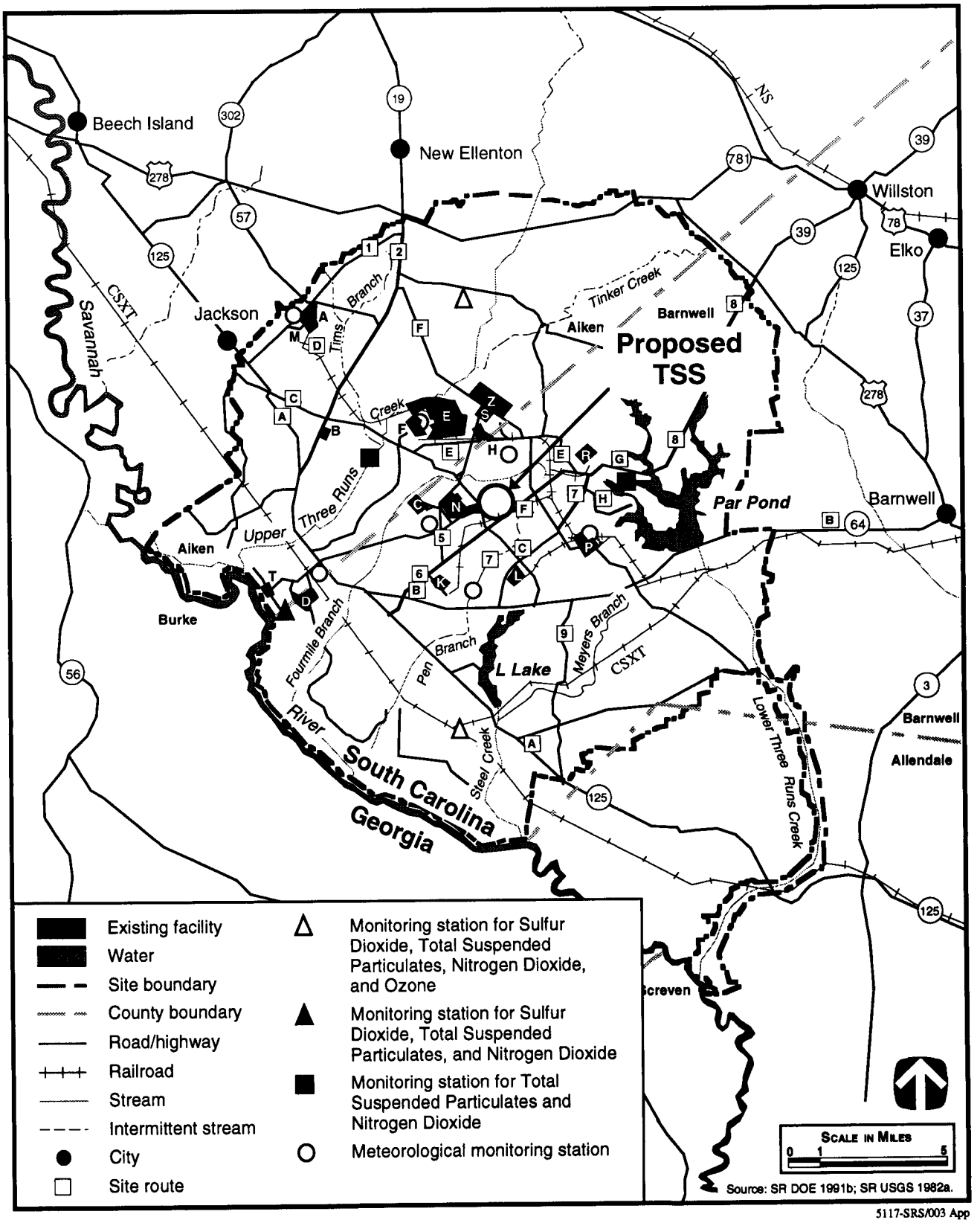



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**FIGURE B.1.3.6–2.—*Ambient Air Quality And Meteorological Stations at Savannah River Site.***

**TABLE B.1.3.6–1.—*Ambient Air Quality Data for Savannah River Site, 1985***

| | Ambient Concentration (μg/m³) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sulfur Dioxide | | | Nitrogen Oxides | Total Suspended Particulates | | Particulate Matter[a] | | Ozone |
| Monitoring Station | Annual | Max. 24-hour | Max. 3-hour | Annual | Annual | Max. 24-hour | Annual | Max. 24-hour | Max. 1-hour |
| Savannah River Site | 5 | 34 | 48 | 6 | 27 | 47 | 27 | 47 | 235 |

[a] Particulate matter less than 10 microns in diameter.
Note: Carbon monoxide and lead were not measured at this site.
Source: SR NUS 1991a.

**TABLE B.1.3.6–2.—*Source Emission Inventory for Savannah River Site, 1987* [Page 1 of 2]**

| | Criteria Pollutant—Emission Rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Carbon Monoxide | | Nitrogen Oxide | | Particulate Matter | | Sulfur Dioxide | |
| Source | Stack (lb/hr) | Area (lb/hr/ft²) | Stack (lb/hr) | Area (lb/hr/ft²) | Stack (lb/hr) | Area (lb/hr/ft²) | Stack (lb/hr) | Area (lb/hr/ft²) |
| 784-A Boiler 1 | 14.0 | | 39.13 | | 10.16 | | 106.8 | |
| 784-A Boiler 2 | 14.0 | | 39.13 | | 10.16 | | 106.8 | |
| 484-D Boiler 1 | 9.6 | | 544.9 | | 21.67 | | 743.0 | |
| 484-D Boiler 2 | 9.6 | | 544.9 | | 21.67 | | 743.0 | |
| 484-D Boiler 3 | 9.6 | | 544.9 | | 21.67 | | 743.0 | |
| 484-D Boiler 4 | 9.6 | | 544.9 | | 21.67 | | 743.0 | |
| 284-H Boiler 1 | 14.0 | | 39.13 | | 10.16 | | 106.8 | |
| 284-H Boiler 2 | 14.0 | | 39.13 | | 10.16 | | 106.8 | |
| 284-H Boiler 3 | 14.0 | | 39.13 | | 10.16 | | 106.8 | |
| 184-K Boiler 1 | 1.1 | | 11.98 | | 2.70 | | 92.0 | |
| 184-K Boiler 2 | 1.1 | | 11.98 | | 2.70 | | 92.0 | |
| 184-P Boiler 1 | 1.1 | | 11.98 | | 2.70 | | 92.0 | |
| H Diesel Gen(2) | 0.794 | | 12.30 | | 0.794 | | 0.794 | |
| F Diesel Gen(2) | 0.714 | | 9.60 | | 0.714 | | 0.714 | |
| K Diesel Gen(2) | 0.873 | | 13.49 | | 0.873 | | 0.873 | |
| L Diesel Gen(2) | 0.873 | | 13.49 | | 0.873 | | 0.873 | |
| P Diesel Gen(2) | 0.873 | | 13.49 | | 0.873 | | 0.873 | |
| Consolidated Incineration Facility | 0.033 | | 8.651 | | | $5.0\times10^{-4}$ | 0.079 | |
| A Source | | $2.8\times10^{-7}$ | | $6.3\times10^{-6}$ | | $2.1\times10^{-7}$ | | $1.9\times10^{-6}$ |
| D Source | | $3.8\times10^{-7}$ | | $8.7\times10^{-6}$ | | $2.9\times10^{-7}$ | | $2.6\times10^{-6}$ |
| H Source | | $3.3\times10^{-7}$ | | $7.6\times10^{-6}$ | | $2.5\times10^{-7}$ | | $2.3\times10^{-6}$ |

**TABLE B.1.3.6–2.—*Source Emission Inventory for Savannah River Site, 1987* [Page 2 of 2]**

| Source | Criteria Pollutant—Emission Rate | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Carbon Monoxide | | Nitrogen Oxide | | Particulate Matter | | Sulfur Dioxide | |
| | Stack (lb/hr) | Area (lb/hr/ft$^2$) | Stack (lb/hr) | Area (lb/hr/ft$^2$) | Stack (lb/hr) | Area (lb/hr/ft$^2$) | Stack (lb/hr) | Area (lb/hr/ft$^2$) |
| F Source | | $2.8\times10^{-7}$ | | $6.3\times10^{-6}$ | | $2.1\times10^{-7}$ | | $1.9\times10^{-6}$ |
| K Source | | $6.1\times10^{-7}$ | | $1.4\times10^{-5}$ | | $4.6\times10^{-7}$ | | $4.2\times10^{-6}$ |
| L Source | | $6.3\times10^{-7}$ | | $1.5\times10^{-5}$ | | $4.8\times10^{-7}$ | | $4.4\times10^{-6}$ |
| P Source | | $6.7\times10^{-7}$ | | $1.5\times10^{-5}$ | | $5.0\times10^{-7}$ | | $4.6\times10^{-6}$ |
| S Source | | $1.3\times10^{-6}$ | | $2.9\times10^{-5}$ | | $9.5\times10^{-7}$ | | $8.7\times10^{-6}$ |
| Z Source | | $1.0\times10^{-5}$ | | $2.4\times10^{-4}$ | | $7.8\times10^{-7}$ | | $7.2\times10^{-5}$ |
| B source | | $1.1\times10^{-6}$ | | $2.6\times10^{-5}$ | | $8.4\times10^{-7}$ | | $7.7\times10^{-6}$ |
| TNX Source | | $3.8\times10^{-6}$ | | $8.8\times10^{-5}$ | | $2.9\times10^{-6}$ | | $2.6\times10^{-5}$ |
| C Source | | $5.9\times10^{-7}$ | | $1.4\times10^{-5}$ | | $4.4\times10^{-7}$ | | $4.1\times10^{-6}$ |
| CS Source | | $5.7\times10^{-7}$ | | $1.3\times10^{-5}$ | | $4.3\times10^{-7}$ | | $3.9\times10^{-6}$ |
| F Pu Separation | | | 137.0 | | | | | |
| H H3 Separation | | | 6.826 | | | | | |
| M Air Stripper | | | 2.302 | | | | | |
| Defense Waste Processing Facility Nitrate Process | | | 8.413 | | | | | |
| S Concrete Batch | | | | | 45.40 | | | |
| D Coal Pile Top | | | | | | $1.9\times10^{-6}$ | | |
| D Coal Pile Bottom | | | | | | $3.9\times10^{-6}$ | | |
| P Coal Pile | | | | | | $1.7\times10^{-6}$ | | |
| K Coal Pile | | | | | | $2.2\times10^{-6}$ | | |
| F Coal Pile | | | | | | $1.8\times10^{-6}$ | | |
| H Coal Pile | | | | | | $1.1\times10^{-6}$ | | |
| A Coal Pile | | | | | | $2.6\times10^{-6}$ | | |
| D Area Coal Crush | | | | | | $8.7\times10^{-4}$ | | |
| D Coal Handling Top | | | | | | $1.6\times10^{-7}$ | | |
| D Coal Handling Bottom | | | | | | $3.5\times10^{-7}$ | | |
| P Coal Handling | | | | | | $1.6\times10^{-7}$ | | |
| K Coal Handling | | | | | | $2.0\times10^{-7}$ | | |
| F Coal Handling | | | | | | $1.6\times10^{-7}$ | | |
| N Coal Handling | | | | | | $9.5\times10^{-8}$ | | |
| A Coal Handling | | | | | | $2.3\times10^{-7}$ | | |

Source: SR NUS 1991a.

**TABLE B.1.3.6–3.—*Emission Rates and Maximum Site Boundary Concentration of Toxic/Hazardous Air Pollutants at Savannah River Site, 1990***

| Pollutant | Emission Rate (tons/yr) | Maximum 24-hour Average Concentration ($\mu g/m^3$) | Proposed South Carolina Ambient Standard ($\mu g/m^3$)[a] |
|---|---|---|---|
| Nitric acid | 9.5 | 3.2 | 125 |
| 1,1,1-Trichloroethane | 10.7 | 3.6 | 9,550 |
| Trichlorotrifluoroethane | 5.5 | 1.8 | [b] |

[a] 24-hour average concentration.
[b] No state standard has been proposed.
Source: SR DHEC 1991a; SR NUS 1991a.

**TABLE B.1.3.6–4.—*Estimated Ambient Concentration of Criteria Pollutants from Existing Sources at Savannah River Site, 1987***

| Pollutant | Averaging Time | Most Stringent Regulations or Guidelines ($\mu g/m^3$) | Maximum Background Concentration[a,b] ($\mu g/m^3$) | SRS Contribution Concentration[a] ($\mu g/m^3$) | Baseline Concentration[a] ($\mu g/m^3$) |
|---|---|---|---|---|---|
| Carbon monoxide | 8-hour | 10,000 | [c] | 38 | 38 |
| | 1-hour | 40,000 | [c] | 154 | 154 |
| Lead | Calendar Quarter | 1.5 | [c] | [d] | [d] |
| Nitrogen dioxide | Annual | 100 | 6 | 16 | 22 |
| Ozone | 1-hour | 235 | 235 | 0 | 235 |
| Particulate matter[e] | Annual | 50 | 27 | 1 | 28 |
| | 24-hour | 150 | 47 | 17 | 64 |
| Sulfur dioxide | Annual | 80 | 5 | 11 | 16 |
| | 24-hour | 365 | 34 | 232 | 266 |
| | 3-hour | 1,300 | 48 | 1,074 | 1,122 |
| Total suspended particulates | Annual | 75 | 27 | 2 | 29 |

[a] The concentrations are the maximum values at or beyond the site boundary.
[b] Ambient air quality monitoring data for 1989-1990 (table B.1.3.6–1).
[c] Not monitored.
[d] No source indicated.
[e] It is assumed that all particulate matter concentrations are total suspended particulate concentrations.
Source: 40 CFR 50; DOE 1992h; DOE 1992i; DOE 1992k; SR DHEC 1991a.

### B.1.4 Environmental Impacts

Major sources of air pollutant emissions for each of the proposed actions at each site during construction and operation are described in sections 4.2.3.3, 4.3.3.3, 4.4.3.3, 4.5.3.3, and 4.6.3.3. The *Environmental and Other Evaluations of Alternatives for Siting, Constructing, and Operating New Production Reactor Capacity* (DOE/NP-0014) contains an analysis for sources due to construction of New Production Reactor capability. The analysis was performed for each of three tritium supply technologies: Modular High Temperature Gas-Cooled Reactor (MHTGR), Light Water Reactor, and Heavy Water Reactor (HWR); which involves facilities considerably larger than those proposed for any of the technologies in this PEIS. The size of each of the tritium supply technologies proposed for each of the five candidate sites (INEL, NTS, ORR, Pantex, and SRS) is 3/8 of a full-sized New Production Reactor (DOE 1992h). The Industrial Source Complex Short-Term model and conservative modeling assumptions were also used and performed in accordance with EPA's *Guideline on Air Quality Models* (EPA-450/2-78-027R) for the *Environmental and Other Evaluations of Alternatives for Siting, Constructing, and Operating New Production Reactor Capacity* (DOE/NP-0014). Resulting impacts for each of the "full-sized" tritium supply technologies were calculated to be less than applicable standards.

For the purposes of this PEIS, it is considered that emissions from construction activities related to the proposed actions would be transitory in nature. It is expected that $PM_{10}$ and/or TSP concentrations would be close to or exceed the 24-hour ambient standards during the peak construction period. These emissions would result from construction activities involving various heavy duty equipment, fuel usage from their operation, and emissions from increased traffic. This potential exceedance is typical of conditions that can occur for projects the size of this proposed action and would generally occur during dry and windy conditions. Appropriate mitigative actions would be followed, such as increased watering, to lower emissions. It is expected that, except for these potential transitory $PM_{10}$ and/or TSP exceedances, all ambient concentrations of criteria and toxic pollutants at, or beyond, each of the site boundaries would remain below applicable national and state ambient air quality standards. Consequently, no emissions inventory is provided for the construction sources.

Potential ambient air quality impacts of the emissions due to operation of each of the tritium supply technologies and recycling facilities at each site were analyzed using the Industrial Source Complex Short-Term computer code described in section B.1.2. The model input data include the emission inventories for the baseline and operation sources for each of the tritium supply technologies and recycling facilities. Emissions from the Large ALWR were used to determine pollutant concentrations since these represent the maximum emission rates from either the Large or Small ALWR. Tables B.1.4–1 through B.1.4–5 provide the emissions inventory at the sites considered for the potential receipt of the tritium supply and recycling facilities and for those sources considered to have a potential impact on ambient air quality related to the action. Tables 4.2.3.3–1, 4.3.3.3–1, 4.4.3.3–1, 4.5.3.3–1, and 4.6.3.3–1 provide a summary of the potential ambient air quality impacts from these sources.

**TABLE B.1.4–1.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Recycling at Idaho National Engineering Laboratory (tons/year)***

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling | | | | Tritium Recycling |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | |
| **Criteria Pollutant** | | | | | | |
| Carbon monoxide | 465 | 11.50 | 39.00 | 14.50 | 4.50 | 4.50 |
| Nitrogen dioxide | 1,393 | 21.00 | 55.50 | 48.00 | 6.00 | 6.00 |
| Particulate matter[a] | 406 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Sulfur dioxide | 2,087 | 0.34 | 0.26 | 0.66 | 0.11 | 0.11 |
| Total suspended particulates[a] | 844 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Volatile organic compounds | 90 | 1.60 | 0.94 | 6.15 | 0.65 | 0.65 |
| **Hazardous and Other Toxic Compounds** | | | | | | |
| Acetone | 0.024 | b | b | 2.00 | b | b |
| Acetylene | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Ammonia | 3.0 | b | b | 1.05 | b | b |
| Ethyl alcohol | b | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Methane | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Methyl alcohol | b | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Nitric acid | 2.2 | 1.20 | b | 14.00 | b | b |
| 1,1,1-Trichloroethane | 1.0 | 0.20 | 0.065 | 4.60 | b | b |
| Trichlorotrifluoroethane | b | 8.50 | b | b | b | b |

[a] It is conservatively assumed that all particulate matter emissions are total suspended particulate emissions.
[b] No sources indicated.
Note: To calculate emissions from tritium supply technologies only, subtract corresponding pollutant emissions of tritium recycling from tritium supply and recycling emissions.
Source: DOE 1995d, DOE 1995e, DOE 1995g; SNL 1995a; INEL 1993a:5.

**TABLE B.1.4–2.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Recycling at Nevada Test Site (tons/year)***

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling | | | | Tritium Recycling |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | |
| **Criteria Pollutant** | | | | | | |
| Carbon monoxide | 5 | 11.50 | 39.00 | 14.50 | 4.50 | 4.50 |
| Nitrogen dioxide | 41 | 21.00 | 55.50 | 48.00 | 6.00 | 6.00 |
| Particulate matter[a] | 26 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Sulfur dioxide | 20 | 0.34 | 0.26 | 0.66 | 0.11 | 0.11 |
| Total suspended particulates[a] | 26 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Volatile organic compounds | b | 1.60 | 0.94 | 6.15 | 0.65 | 0.65 |
| **Hazardous and Other Toxic Compounds** | | | | | | |
| Acetone | b | b | b | 2.00 | b | b |
| Acetylene | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Ammonia | b | b | b | 1.05 | b | b |
| Ethyl alcohol | b | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Methane | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Methyl alcohol | b | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Nitric acid | b | 1.20 | b | 14.00 | b | b |
| 1,1,1-Trichloroethane | b | 0.20 | 0.065 | 4.60 | b | b |
| Trichlorotrifluoroethane | b | 8.50 | b | b | b | b |

[a] It is conservatively assumed that all particulate matter emissions are total suspended particulate emissions.

[b] No sources indicated.

Note: To calculate emissions from tritium supply technologies only, subtract corresponding pollutant emissions of tritium recycling from tritium supply and recycling emissions.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NTS 1993a:4.

**TABLE B.1.4–3.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Recycling at Oak Ridge Reservation (tons/year)***

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling | | | | Tritium Recycling |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | |
| **Criteria Pollutant** | | | | | | |
| Carbon monoxide | 104 | 11.50 | 39.00 | 14.50 | 4.50 | 4.50 |
| Nitrogen dioxide | 960 | 21.00 | 55.50 | 48.00 | 6.00 | 6.00 |
| Particulate matter[a] | 20 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Sulfur dioxide | 1,070 | 0.34 | 0.26 | 0.66 | 0.11 | 0.11 |
| Total suspended particulates[a] | 20 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Volatile organic compounds | 4 | 1.60 | 0.94 | 6.15 | 0.65 | 0.65 |
| **Hazardous and Other Toxic Compounds** | | | | | | |
| Acetone | b | b | b | 2.00 | b | b |
| Acetylene | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Ammonia | b | b | b | 1.05 | b | b |
| Chlorine | 1.82 | b | b | b | b | b |
| Chlorodifluoromethane | 3.85 | b | b | b | b | b |
| Dichlorodifluoromethane | 3.37 | b | b | b | b | b |
| Ethyl alcohol | b | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Hydrogen chloride | 7.72 | b | b | b | b | b |
| Methane | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Methyl alcohol | 29.11 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Nitric acid | 10.5 | 1.20 | b | 14.00 | b | b |
| Sulfuric acid | 2.71 | b | b | b | b | b |
| Tetrachloroethylene | 13.50 | b | b | b | b | b |
| 1,1,1-Trichloroethane | 0.82 | 0.20 | 0.065 | 4.60 | b | b |
| Trichlorofluoromethane | 8.80 | b | b | b | b | b |
| Trichlorotrifluoroethane | 3.02 | 8.50 | b | b | b | b |

[a] It is conservatively assumed that all particulate matter emissions are total suspended particulate emissions.
[b] No sources indicated.
Note: To calculate emissions from tritium supply technologies only, subtract corresponding pollutant emissions of tritium recycling from tritium supply and recycling emissions.
Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8.

**TABLE B.1.4–4.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Recycling at Pantex Plant (tons/year)* [Page 1 of 2]**

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling | | | | Tritium Recycling |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | |
| **Criteria Pollutant** | | | | | | |
| Carbon monoxide | 17.0 | 11.50 | 39.00 | 14.50 | 4.50 | 4.50 |
| Nitrogen Dioxide | 50.0 | 21.00 | 55.50 | 48.00 | 6.00 | 6.00 |
| Particulate Matter[a] | 2.30 | 3.30 | 1.72 | 2.30 | 1.45 | 1.45 |
| Sulfur Dioxide | 1.0 | 0.34 | 0.26 | 0.66 | 0.11 | 0.11 |
| Volatile Organic Compounds | 14.0 | 1.60 | 0.94 | 6.15 | 0.65 | 0.65 |

**TABLE B.1.4–4.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Recycling at Pantex Plant (tons/year)* [Page 2 of 2]**

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling | | | | Tritium Recycling |
|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | |
| **Hazardous and Other Toxic Compounds** | | | | | | |
| Acetone | 6.82 | b | b | 2.00 | b | b |
| Acetylene | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Ammonia | b | b | b | 1.05 | b | b |
| Aliphatic hydrocarbons | 0.11 | b | b | b | b | b |
| Aromatic hydrocarbons | 0.15 | b | b | b | b | b |
| Aromatic petroleum distillate | 0.08 | b | b | b | b | b |
| 2-Butoxyethanol | 4.47 | b | b | b | b | b |
| Butyl acetate | 0.48 | b | b | b | b | b |
| Butyl alcohol | 0.18 | b | b | b | b | b |
| Chlorodifluoromethane | 0.10 | b | b | b | b | b |
| Cyanogen | 0.26 | b | b | b | b | b |
| Dichlorodifluoromethane | 0.15 | b | b | b | b | b |
| Diesel fuel | 0.05 | b | b | b | b | b |
| Ethyl alcohol | 0.12 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Epoxy solvent | 0.09 | b | b | b | b | b |
| Freon TF | 0.53 | b | b | b | b | b |
| Hydrocarbons | 2.75 | b | b | b | b | b |
| Hydrogen chloride | 0.37 | b | b | b | b | b |
| Hydrogen fluoride | 0.46 | b | b | b | b | b |
| Isopropyl alcohol | 0.74 | b | b | b | b | b |
| Methane | b | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 |
| Methyl alcohol | 3.80 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| Methyl ethyl ketone | 0.53 | b | b | b | b | b |
| Methyl isobutyl ketone | 0.06 | b | b | b | b | b |
| Nitric acid | b | 1.20 | b | 14.00 | b | b |
| Tert-butyl-ether | 0.18 | b | b | b | b | b |
| Tetrahydrofuran | 0.63 | b | b | b | b | b |
| Toluene | 3.37 | b | b | b | b | b |
| 1,1,1-Trichloroethane | 0.075 | 0.20 | 0.065 | 4.60 | b | b |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane | 0.11 | b | b | b | b | b |
| Trichlorotrifluoroethane | 0.14 | 8.50 | b | b | b | b |
| VM&P naptha | 0.13 | b | b | b | b | b |
| Xylene | 0.09 | b | b | b | b | b |

[a] It is conservatively assumed that all particulate matter emissions are total suspended particulate emissions.

[b] No sources indicated.

Note: To calculate emissions from tritium supply technologies only, subtract corresponding pollutant emissions of tritium recycling from tritium supply and recycling emissions.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX 1993a:2.

**TABLE B.1.4–5.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Upgraded Recycling at Savannah River Site (tons/year)* [Page 1 of 2]**

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling Upgrade | | | | Tritium Recycling Upgrade | Tritium Recycling Phaseout |
|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | | |
| **Criteria Pollutant** | | | | | | | |
| Carbon monoxide | 462.0 | 21.00 | 48.50 | 24.00 | 14.00 | 14.00 | (0.43) |
| Nitrogen dioxide | 3,129.0 | 55.55 | 90.00 | 82.50 | 40.50 | 40.50 | (1.96) |
| Particulate matter[a] | 531.0 | 20.85 | 19.27 | 19.85 | 19.00 | 19.00 | (0.14) |
| Sulfur dioxide | 6,915.0 | 80.23 | 80.16 | 80.55 | 80.00 | 80.00 | (0.13) |
| Total suspended particulates[a] | 1,021.0 | 1.95 | 0.37 | 0.95 | 0.10 | 0.10 | b |
| Volatile organic compounds | b | 1.25 | 0.59 | 5.80 | 0.30 | 0.30 | b |
| **Hazardous and Other Toxic Compounds** | | | | | | | |
| Acetone | b | b | b | 2.00 | b | b | b |
| Acetylene | b | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | b |
| Acrolein | 0.08 | b | b | b | b | b | b |
| Acrylonitrile | 0.08 | b | b | b | b | b | b |
| Ammonia | b | b | b | 1.05 | b | b | b |
| Antimony | 0.05 | b | b | b | b | b | b |
| Benzene | 124.0 | b | b | b | b | b | b |
| Cadmium | 0.05 | b | b | b | b | b | b |
| Cadmium Oxide | 0.06 | b | b | b | b | b | b |
| Chlorine | 6.54 | b | b | b | b | b | b |
| 2,4-Dinitrotoluene | 1.0 | b | b | b | b | b | b |
| Dioctyl Phthalate | 0.12 | b | b | b | b | b | b |
| Ethyl Alcohol | b | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | b |
| Ethyl Benzene | 1.17 | b | b | b | b | b | b |
| Ethyl Glycol | 0.44 | b | b | b | b | b | b |
| Formic Acid | 1.60 | b | b | b | b | b | b |
| Hexane | 0.22 | b | b | b | b | b | b |
| Hydrogen chloride | 155.0 | b | b | b | b | b | b |
| Hydrogen sulfide | 4.53 | b | b | b | b | b | b |
| Manganese | 0.34 | b | b | b | b | b | b |
| Mercury | 0.17 | b | b | b | b | b | b |
| Methane | b | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | b |
| Methyl alcohol | 0.35 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | (0.007) |
| Methyl ethyl ketone | 4.41 | b | b | b | b | b | (0.005) |
| Methyl isobutyl ketone | 2.28 | b | b | b | b | b | b |
| Methyl tert-butyl ether | 1.71 | b | b | b | b | b | b |
| Methylene chloride | 1.19 | b | b | b | b | b | b |
| Nickel | 0.24 | b | b | b | b | b | b |
| Nickel oxide | 0.05 | b | b | b | b | b | b |
| Nitric acid | 2.59 | 1.20 | b | 14.00 | b | b | b |

**TABLE B.1.4–5.—*Potential Air Emissions Resulting from Tritium Supply Technologies and Upgraded Recycling at Savannah River Site (tons/year)* [Page 2 of 2]**

| Pollutant | 2010 No Action | Tritium Supply Technologies and Recycling Upgrade | | | | Tritium Recycling Upgrade | Tritium Recycling Phaseout |
|---|---|---|---|---|---|---|---|
| | | HWR | MHTGR | ALWR | APT | | |
| **Hazardous and Other Toxic Compounds (continued)** | | | | | | | |
| Sodium hydroxide | 0.35 | b | b | b | b | b | b |
| Sulfuric acid | 0.05 | b | b | b | b | b | b |
| Tetrachloroethylene | 28.80 | b | b | b | b | b | b |
| Toluene | 1.55 | b | b | b | b | b | (0.007) |
| 1,1,1-Trichloroethane | 1.20 | 0.20 | 0.065 | b | 4.60 | b | b |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane | 0.08 | b | b | b | b | b | b |
| Trichloroethylene | 9.80 | b | b | b | b | b | b |
| Trichloromethane | 28.30 | b | b | b | b | b | b |
| Trichlorotrifluoroethane | b | 8.50 | b | b | b | b | b |
| Xylene | 20.60 | b | b | b | b | b | (0.011) |

[a] It is conservatively assumed that all particulate matter emissions are total suspended particulate emissions.

[b] No source indicated.

Note: To calculate emissions from tritium supply technologies only, subtract corresponding pollutant emissions of tritium upgrade from tritium supply and upgraded recycling emissions.

Note: Numbers in parenthesis indicate a net reduction in emissions.

Source: DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; SR DOE 1995a; SR NUS 1991a; SRS 1993a:3.

## B.2 ACOUSTICS

### B.2.1 Introduction

This section provides a summary of local noise regulations. A qualitative discussion of construction and operation noise sources and the potential for noise impacts is provided in PEIS section 4.X.2 Affected Environment and 4.X.3 Environmental Impacts. Further analysis of construction and operation noise impacts, including traffic noise impacts and impacts from outside sources, has been deferred to the tiered, site-specific NEPA documents.

The Occupational Safety and Health Administration standards for occupational noise exposure (29 CFR 1910) are applicable for worker protection at the site, as discussed in section 5.5.

### B.2.2 Supporting Data

This section provides a discussion of local noise regulations and presents any available sound level monitoring data for the sites. There are no community noise regulations applicable to INEL, NTS, and Pantex.

#### B.2.2.1 *Oak Ridge Reservation*

Maximum allowable noise limits for the city of Oak Ridge are presented in table B.2.2.1–1.

#### B.2.2.2 *Savannah River Site*

Ambient sound level data collected at SRS in 1989 and 1990 are summarized in *Sound-Level Characterization of the Savannah River Site* (NUS-5251). The States of Georgia and South Carolina, and the counties where SRS is located, have not yet established noise regulations that specify acceptable community noise levels except for a provision of the Aiken County Nuisance Ordinance which limits daytime and nighttime noise by frequency band (table B.2.2.2–1).

**TABLE B.2.2.1–1.—*City of Oak Ridge Maximum Allowable Noise Limits Applicable to Oak Ridge Reservation***

| Adjacent Use | Where Measured | Maximum Sound Level (dBA) |
|---|---|---|
| All residential districts | Common lot line | 50 |
| Neighborhood business district | Common lot line | 55 |
| General business district | Common lot line | 60 |
| Industrial district | Common lot line | 65 |
| Major street | Street lot line | 75 |
| Secondary residential street | Street lot line | 60 |

Source: OR City 1985a.

**TABLE B.2.2.2–1.—*Aiken County Maximum Allowable Noise Levels*[a]**

| Frequency Band (Hz) | Nighttime (9:00 p.m. - 7:00 a.m.) Sound Pressure Levels (dB) | |
|---|---|---|
| | Nonresidential Lot Line | Residential Lot Line |
| 20 - 75 | 69 | 65 |
| 75 - 150 | 60 | 50 |
| 150 - 300 | 56 | 43 |
| 300 - 600 | 51 | 38 |
| 600 - 1,200 | 42 | 33 |
| 1,200 - 2,400 | 40 | 30 |
| 2,400 - 4,800 | 38 | 28 |
| 4,800 10,000 | 35 | 20 |

[a] Daytime (7:00 a.m. - 9:00 p.m.) sound pressure levels: apply one of the following corrections (dB) to the nighttime levels above: daytime operation only, +5; source operates less than 20 percent of any 1-hour period, +5; source operates less than 5 percent of any 1-hour period, +10; source operates less than 1 percent of any 1-hour period, +15; noise of impulsive character, -5; noise of periodic character, -5

Source: SR County 1991a.

# APPENDIX C

# Appendix C

# APPENDIX C: BIOTIC RESOURCES

This appendix includes tables which contain the scientific names of common, nonthreatened, and nonendangered plant and animal species found in the text. Additionally, tables are presented listing flora and fauna identified by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service, and state governments as threatened, endangered, or other special status. Special status species include Federal candidate species (Category 1 and 2) and state classifications such as species of concern, state sensitive species, monitor species, or species in need of management. Flora and fauna designated Category 3 by the Federal government are not listed in the tables because they are no longer under consideration for possible addition to the list of threatened and endangered species. The threatened, endangered, and special status lists include all such species which could potentially occur in a site area regardless of their residence status (i.e., breeding, year round, summer, winter, or migratory) or likelihood of being affected by reconfiguration. By comparison, species listed in the affected environment sections in chapters 4 and 5 are only those species that are likely to be found in site areas which may be affected by reconfiguration. All tables list species in alphabetical order by common name.

**TABLE C–1.—*Scientific Names of Common Nonthreatened and Nonendangered Plant and Animal Species Referred to in the Text* [Page 1 of 2]**

| Common Name | Scientific Name | Common Name | Scientific Name | Common Name | Scientific Name | Common Name | Scientific Name |
|---|---|---|---|---|---|---|---|
| **Mammals** | | **Mammals** (continued) | | **Birds** (continued) | | **Reptiles** | |
| Badger | *Taxidea taxus* | Pronghorn | *Antilocapra americana* | Golden eagle | *Aquila chrysaetos* | Box turtle | *Terrapene carolina* |
| Black-tailed jackrabbit | *Lepus californicus* | Raccoon | *Procyon lotor* | Great horned owl | *Bubo virginianus* | Desert iguana | *Dipsosaurus dorsalis* |
| Black-tailed prairie dog | *Cynomys ludovicianus* | Round-tailed ground squirrel | *Spermophilus tereticaudus* | Horned lark | *Eremophila alpestris* | Eastern garter snake | *Thamnophis sirtalis* |
| Bobcat | *Lynx rufus* | Townsend's ground squirrel | *Spermophilus townsendii* | Mourning dove | *Zenaida macroura* | Gopher snake | *Pituophis melanoleucus* |
| Coyote | *Canis latrans* | White-footed mouse | *Peromyscus leucopus* | Northern cardinal | *Cardinalis cardinalis* | Short-horned lizard | *Phyrnosoma douglassi* |
| Eastern cottontail | *Sylvilagus floridanus* | Whitetail deer | *Odocoileus virginianus* | Northern harrier | *Circus cyaneus* | Side-blotched lizard | *Uta stansburiana* |
| Elk | *Cervus elaphus* | **Birds** | | Prairie falcon | *Falco mexicanus* | Western shovel-nosed snake | *Chionactis occipitalis* |
| Feral hog | *Sus scrofa* | American kestrel | *Falco sparverius* | Red-tailed hawk | *Buteo jamaicensis* | **Amphibians** | |
| Gray fox | *Urocyon cinereoargenteus* | Black vulture | *Coragyps atratus* | Roadrunner | *Geococcyx californianus* | American toad | *Bufo americanus* |
| Great Basin pocket mouse | *Perognathus parvus* | Black-throated sparrow | *Amphispiza bilineata* | Rough-legged hawk | *Buteo lagopus* | Slimy salamander | *Plethodon glutinosus* |
| Hispid cotton rat | *Sigmodon hispidus* | Bobwhite quail | *Colinus virginianus* | Sage grouse | *Centrocercus urophasianus* | **Fishes** | |
| Long-tailed weasel | *Mustela frenata* | Burrowing owl | *Athene cunicularia* | Sage sparrow | *Amphispiza belli* | American shad | *Alosa sapidissima* |
| Merriam's kangaroo rat | *Dipodomys merriami* | Carolina chickadee | *Parus carolinensis* | Scaled quail | *Callipepa squamata* | Banded sculpin | *Cottus carolinae* |
| Mink | *Mustela vison* | Common crow | *Corvus brachyrhynchos* | Turkey vulture | *Cathartes aura* | Black crappie | *Pomoxis nigromaculatus* |
| Mountain lion | *Felis concolor* | Cooper's hawk | *Accipiter cooperii* | Western meadowlark | *Sturnella neglecta* | Blacknose dace | *Rhinichthys atratulus* |
| Mule deer | *Odocoileus hemionus* | Gambel's quail | *Callipepla gambelii* | Banded gecko | *Coleonyx variegatus* | Bluegill | *Lepomis macrochirus* |

**TABLE C–1.—*Scientific Names of Common Nonthreatened and Nonendangered Plant and Animal Species Referred to in the Text* [Page 2 of 2]**

| Common Name | Scientific Name | Common Name | Scientific Name | Common Name | Scientific Name | Common Name | Scientific Name |
|---|---|---|---|---|---|---|---|
| **Fishes** (continued) | | **Fishes** (continued) | | **Plants** (continued) | | **Plants** (continued) | |
| Bluntnose minnow | *Pimephales notatus* | Sauger | *Stizostedion canadense* | Giant wildrye | *Elymus condensatus* | Red brome | *Bromus rubens* |
| Bream | *Lepomis spp.* | Shorthead sculpin | *Cottus confusus* | Gray horsebrush | *Tetradymia canescens* | Russian thisle | *Salsola kali* |
| Bullhead | *Ictalurus spp.* | Speckled dace | *Rhinichthys osculus* | Green rabbitbush | *Chrysothamnus greenei* | Sagebrush | *Artemisia spp.* |
| Central stoneroller | *Campostoma anomalum* | Striped bass | *Morone saxatilis* | Hemlock | *Tsuga canadensis* | Saltbush | *Atriplex spp.* |
| Crappie | *Pomoxis spp.* | Sunfish | *Lepomis spp.* | Hickory | *Carya spp.* | Shortleaf pine | *Pinus echinata* |
| Creek chub | *Semotilus atromaculatus* | **Plants** | | Hopsage | *Grayia spinosa* | Side oats grama | *Bouteloua curtipendula* |
| Golden shiner | *Notemigonus crysoleucas* | Bald cypress | *Taxodium distichum* | Indian ricegrass | *Oryzopsis hymenoides* | Slash pine | *Pinus elliottii* |
| Goldfish | *Carassius auratus* | Big sagebrush | *Artemisia tridentata* | Juniper | *Juniperus spp.* | Thickspike wheatgrass | *Agropyron dasytachyum* |
| Hickory shad | *Alosa mediocris* | Blackbrush | *Coleogyne ramosissima* | Little bluestem | *Schizachyrium scoparium* | Threetip sagebrush | *Artemisia tripartita* |
| Kokanee salmon | *Oncorhynchus nerka* | Blue grama | *Bouteloua gracilis* | Loblolly pine | *Pinus taeda* | Tupelo | *Nyssa slyvotica* |
| Lake chubsucker | *Erimyzon sucetta* | Bluebunch wheatgrass | *Agropyron spicatum* | Longleaf pine | *Pinus taeda* | Utah juniper | *Juniperus osteosperma* |
| Largemouth bass | *Micropterus salmoides* | Bottlebrush squirreltail | *Sitanion hystrix* | Low sagebrush | *Artemisia arbuscula* | Virginia pine | *Pinus virginiana* |
| Mosquitofish | *Gambusia affinis* | Buffalo-grass | *Buchloe dactyloides* | Needle-and-thread grass | *Stipa comata* | Western wheatgrass | *Agropyron smithii* |
| Mountain whitefish | *Prosopium williamsoni* | Cheatgrass | *Bromus tectorum* | Oak | *Quercus spp.* | White pine | *Pinus strobus* |
| Mud sunfish | *Acantharchus pomotis* | Cottonwood | *Populus spp.* | Pine | *Pinus spp.* | Willow | *Salix spp.* |
| Pickerel | *Esox spp.* | Creosote bush | *Larrea tridentata* | Pinyon pine | *Pinus edulis* | Winterfat | *Ceratoides lanata* |
| Redbreast sunfish | *Lepomis auritus* | Crested wheatgrass | *Agropyron desertorum* | Poverty-weed | *Monolepis nuttaliana* | | |
| Redfin pickerel | *Esox americanus* | Desert thorn | *Lycium pallidum* | Prickly pear cactus | *Opuntia spp.* | | |
| Rock bass | *Ambloplites rupestris* | Desert thorn | *Lycium shockleyi* | Rabbitbrush | *Chrysothamnus spp.* | | |

**TABLE C–2.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Idaho National Engineering Laboratory***

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Mammals** | | | |
| California myotis | *Myotis californicus* | C2 | NL |
| Fringed myotis | *Myotis thysanodes* | NL | SSC |
| Pygmy rabbit | *Brachylagus idahoensis* | C2 | NL |
| Townsend's western big-eared bat | *Plecotus townsendii townsendii* | C2 | SSC |
| Western pipistrelle | *Pipistrellus hesperus* | NL | SSC |
| **Birds** | | | |
| American white pelican | *Pelecanus erythrorhynchos* | NL | SSC |
| Bald eagle[b] | *Haliaeetus leucocephalus* | E | E |
| Common loon | *Gavia immer* | NL | SSC |
| Ferruginous hawk[c] | *Buteo regalis* | C2 | SSC |
| Great egret | *Casmerodius albus* | NL | SSC |
| Loggerhead shrike | *Lanius ludovicanus* | C2 | NL |
| Merlin | *Falco columbarius* | NL | SSC |
| Northern goshawk | *Accipiter gentilis* | C2 | NL |
| Peregrine falcon[b] | *Falco peregrinus* | E | E |
| White-faced ibis | *Plegadis chihi* | C2 | NL |
| **Plants[d]** | | | |
| King's bladderpod | *Lesquerella kingii var. cobrensis* | NL | M |
| Large-flowered gymnosteris | *Gymnosteris nudicaulis* | NL | M |
| Lemhi milkvetch | *Astragalus aquilonius* | NL | SP2 |
| Nipple cactus | *Coryphantha missouriensis* | NL | M |
| Tree-like oxytheca | *Oxytheca dendroidea* | NL | S |
| Painted milkvetch | *Astragalus ceramicus var. apus* | NL | M |
| Plains milkvetch | *Astragalus gilviflorus* | NL | SP1 |
| Spreading gilia | *Gilia polycladon* | NL | SP2 |
| Thistle milkvetch | *Astragalus kentrophyta var. jessiae* | NL | S |
| Winged-seed evening primrose | *Camissonia pterosperma* | NL | S |

[a] Status codes: C2 - candidate Category 2 (possible appropriate to list); E - endangered; M - monitor; NL - not listed; S - sensitive; SP1 - State priority 1 (in danger of becoming extinct in the state); SP2 - State priority 2 (likely to be classified as Priority 1 if factors contributing to decline remain unchanged), SSC - state special concern.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur on proposed tritium supply site.

[d] State status of plant species is designated by the Idaho Native Plant Society.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; DOE 1992e; DOE 1994e; IN DFG 1992a; IN DOE 1984a.

**TABLE C–3.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Nevada Test Site***

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Mammal** | | | |
| Spotted bat | *Euderma maculatum* | C2 | NL |
| **Birds** | | | |
| American peregrine falcon[b,c] | *Falco peregrinus anatum* | E | E |
| Arctic peregrine falcon[b] | *Falco peregrinus tundrius* | T | NL |
| Bald eagle[c] | *Haliaeetus leucocephalus* | E | E |
| Ferruginous hawk[d] | *Buteo regalis* | C2 | NL |
| Loggerhead shrike[d] | *Lanius ludovicianus* | C2 | NL |
| Mountain plover[d] | *Charadrius montanus* | C2 | NL |
| Western least bittern | *Ixobrychus exilis hesperis* | C2 | NL |
| Western snowy plover[d] | *Charadrius alexandrinus nivosus* | C2 | NL |
| White-faced ibis[d] | *Plegadis chihi* | C2 | NL |
| **Reptiles** | | | |
| Chuckwalla | *Sauromalus obesus* | C2 | NL |
| Desert tortoise [d,e] | *Gopherus agassizii* | T | T |
| **Fish** | | | |
| Devils Hole pupfish[c,f] | *Cyprinodon diabolis* | E | E |
| **Plants** | | | |
| Amargosa penstemon | *Penstemon fruticiformis amargosae* | C2 | NL |
| Beardtongue[d] | *Penstemon pahutensis* | C2 | NL |
| Beatley milkvetch[d] | *Astragalus beatleyae* | C1 | CE |
| Beatley phacelia[d] | *Phacelia beatleyae* | C2 | NL |
| Black wooly-pod[d] | *Astragalus funereus* | C2 | NL |
| Camissonia megalantha[d] | *Camissonia megalantha* | C2 | NL |
| Cymopterus | *Cymopterus ripleyi var. saniculoides* | C2 | NL |
| Green-gentian[d] | *Frasera pahutensis* | C2 | NL |
| Kingston bedstraw[d] | *Galium hilendiae kingstonense* | C2 | NL |
| Mojave fishhook cactus[d] | *Sclerocactus polyancistrus* | NL | CY |
| White bear desert-poppy[d] | *Arctomecon merriamii* | C2 | NL |

[a] Status codes: C1 – candidate Category 1 (appropriate to list); C2 - candidate Category 2 (possible appropriate to list); CE - critically endangered by authority of NRS 527.270 (State Division of Forestry); CY - protected by authority of NRS 522.60–.120 (Nevada Cacti and Yucca Law); NL - not listed; T - threatened.

[b] Peregrine falcon seen on NTS; however not identified to subspecies level.

[c] USFWS Recovery Plan exists for this species.

[d] Species recorded on NTS.

[e] Species known to occur on proposed tritium supply site.

[f] Only known location of this species is outside the NTS 24 miles southwest of Mercury. This species is included here due to potential offsite groundwater impacts.

Note: Nevada Department of Wildlife and currently revising the state threatened and endangered species list.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; DOE 1994j; NT FWS 1989a; NT FWS 1991a; NTS 1990a:1; NTS 1990a:2.

**TABLE C–4.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Oak Ridge Reservation* [Page 1 of 3]**

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Mammals** | | | |
| Eastern cougar[b] | *Felis concolor couguar* | E | E |
| Eastern woodrat | *Neotoma floridana magister* | C2 | D |
| Gray bat[b] | *Myotis grisescens* | E | E |
| Indiana bat[b] | *Myotis sodalis* | E | E |
| River otter | *Lutra canadensis* | NL | T |
| Smoky shrew | *Sorex fumeus* | NL | D |
| Southeastern shrew | *Sorex longirostris* | NL | D |
| **Birds** | | | |
| American peregrine falcon[b] | *Falco peregrinus anatum* | E | E |
| Arctic peregrine falcon | *Falco peregrinus tundrius* | T | E |
| Bachman's sparrow | *Aimophila aestivalis* | C2 | E |
| Bald eagle[b] | *Haliaeetus leucocephalus* | E | E |
| Barn owl | *Tyto alba* | NL | D |
| Bewick's wren | *Thyromanes bewickii altus* | C2 | T |
| Black-crowned night heron | *Nycticorax nycticorax* | NL | D |
| Black vulture[c] | *Coragyps atratus* | NL | D |
| Cooper's hawk[c] | *Accipiter cooperii* | NL | T |
| Grasshopper sparrow | *Ammodramus savannarum* | NL | T |
| Northern harrier | *Circus cyaneus* | NL | T |
| Osprey | *Pandion haliaetus* | NL | E |
| Red-cockaded woodpecker | *Picoides borealis* | E | E |
| Red-shouldered hawk[c] | *Buteo lineatus* | NL | D |
| Red-headed woodpecker | *Melanerpes erythrocephalus* | NL | D |
| Sharp-shinned hawk[c] | *Accipiter striatus* | NL | T |
| **Reptiles** | | | |
| Cumberland slider | *Chrysemys scripta troosti* | NL | D |
| Eastern slender glass lizard | *Ophisaurus attennatus longicaudus* | NL | D |
| Northern pine snake | *Pituophis melanoleucus melanoleucus* | C2 | T |
| Six-lined racerunner | *Cnemidophorus sexlineatus* | NL | D |
| **Amphibians** | | | |
| Green salamander | *Aneides aeneus* | NL | D |
| Hellbender[c] | *Cryptobranchus alleganiensis* | C2 | D |
| Tennessee cave salamander | *Gyrinophilus palleucus* | C2 | T |
| **Fishes** | | | |
| Alabama shad | *Alosa alabamae* | NL | D |
| Amber darter[b] | *Percina antesella* | E | E |
| Blue sucker | *Cycleptus elongatus* | C2 | T |
| Flame chub | *Hemitremia flammea* | NL | D |
| Frecklebelly madtom | *Noturus munitus* | C2 | T |
| Highfin carpsucker | *Carpiodes velifer* | NL | D |
| Spotfin chub[b] | *Cyprinella monacha* | T | E |

TABLE C–4.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Oak Ridge Reservation* [Page 2 of 3]

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Fishes** (continued) | | | |
| Tennessee dace[c] | *Phoxinus tennesseensis* | NL | D |
| Yellowfin madtom[b] | *Noturus flavipinnis* | T | E |
| **Invertebrates** | | | |
| Alabama lamp pearly mussel[b] | *Lampsilis virescens* | E | E |
| Appalachian monkeyface pearly mussel[b] | *Quadrula sparsa* | E | E |
| Birdwing pearly mussel[b] | *Conradilla caelata* | E | E |
| Cumberland bean pearly mussel[b] | *Villosa trabalis* | E | E |
| Cumberland monkeyface pearly mussel[b] | *Quadrula intermedia* | E | E |
| Dromedary pearly mussel[b] | *Dromus dromas* | E | E |
| Fine-rayed pigtoe pearly mussel[b] | *Fusconaia cuneolus* | E | E |
| Green-blossom pearly mussel[b] | *Epioblasma torulosa gubernaculum* | E | E |
| Orange-footed pearly mussel[b] | *Plethobasus cooperianus* | E | E |
| Painted snake coiled forest snail | *Anguispira picta* | T | E |
| Pale lilliput pearly mussel[b] | *Toxolasma cylindrellus* | E | E |
| Pink mucket pearly mussel[b] | *Lampsilis orbiculata orbiculata* | E | E |
| Rough pigtoe pearly mussel[b] | *Pleurobema plenum* | E | E |
| Shiny pigtoe pearly mussel[b] | *Fusconaia edgariana* | E | E |
| Tan riffle shell pearly mussel[b] | *Epioblasma walkeri* | E | E |
| Tubercled-blossom pearly mussel[b] | *Epioblasma torulosa torulosa* | E | E |
| Turgid-blossom pearly mussel[b] | *Epioblasma turgidula* | E | E |
| White warty back pearly mussel[b] | *Plethobasus cicatricosus* | E | E |
| Yellow-blossom pearly mussel[b] | *Epioblasma florentina florentina* | E | E |
| **Plants** | | | |
| American barberry | *Berberis canadensis* | NL | S |
| Appalachian bugbane | *Cimicifuga rubifolia* | C2 | T |
| Branching whitlowgrass | *Draba ramosissima* | NL | S |
| Butternut | *Juglans cinerea* | C2 | T |
| Canada (wild yellow) lily[c] | *Lilium canadense* | NL | T |
| Carey's saxifrage | *Saxifraga careyana* | NL | S |
| Catfoot | *Gnaphalium helleri* | NL | S |
| Earleaf falsefoxglove | *Tomanthera auriculata* | C2 | E |
| Fen orchid[c] | *Liparis loeselii* | NL | E |
| Ginseng[c] | *Panax quinquefolius* | NL | T |
| Golden seal[c] | *Hydrastis canadensis* | NL | T |
| Gravid sedge[c] | *Carex gravida* | NL | S |
| Heartleaf meehania | *Meehania cordata* | NL | T |
| Lesser ladies' tresses | *Spiranthes ovalis* | NL | S |
| Michigan lily[c] | *Lilium michiganense* | NL | T |
| Mountain honeysuckle | *Lonicera dioica* | NL | S |

**TABLE C–4.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Oak Ridge Reservation* [Page 3 of 3]**

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Plants** (continued) | | | |
| Mountain witch alder | *Fothergilla major* | NL | T |
| Northern bush honeysuckle | *Diervilla lonicera* | NL | T |
| Nuttall waterweed | *Elodea nuttallii* | NL | S |
| Pink lady's-slipper[c] | *Cypripedium acaule* | NL | E |
| Prairie goldenrod | *Solidago ptarmicoides* | NL | E |
| Purple fringeless orchid[c] | *Platanthera peramoena* | NL | T |
| Slender blazing star | *Liatris cylindracea* | NL | E |
| Spreading false foxglove | *Aureolaria patula* | C1 | T |
| Swamp lousewort | *Pedicularis lanceolata* | NL | T |
| Whorled mountainmint | *Pycanthemum verticallum* | NL | E,P |
| Tall larkspur | *Delphinium exaltatum* | C2 | E |
| Tennessee purple coneflower[b] | *Echinacea tennesseenis* | E | E |
| Tubercled rein-orchid[c] | *Platanthera flava* | NL | T |
| Virginia spiraea | *Spiraea virginiana* | T | E |

[a] Status codes: C1 - candidate Category 1 (appropriate to list); C2 - candidate Category 2 (possibly appropriate to list); D - deemed in need of management; E - endangered; NL - not listed; SSC - State, special concern.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur on or near proposed tritium supply site.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; DOE 1994j; OR DEC 1992a; OR DEC 1992b; OR DEC 1992c; OR DEC 1992d; OR DOE 1990a; OR FWS 1992b; OR NERP 1993a; OR WRC 1991a; OR WRC 1991b; ORNL 1981a; ORNL 1984b; ORNL 1988c.

**TABLE C–5.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Pantex Plant***

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Mammals** | | | |
| Black-footed ferret[b,c] | *Mustela nigripes* | E | E |
| Plains spotted skunk | *Spilogale putorius interrupta* | C2 | NL |
| Swift fox[d] | *Vulpes velox* | C2 | NL |
| **Birds** | | | |
| American peregrine falcon[b] | *Falco peregrinus anatum* | E | E |
| Arctic peregrine falcon | *Falco peregrinus tundrius* | T | T |
| Bald eagle[b,d] | *Haliaeetus leucocephalus* | E | E |
| Baird's sparrow | *Ammodramus bairdii* | C2 | NL |
| Black tern[d] | *Chlidonias niger* | C2 | NL |
| Ferruginous hawk[d] | *Buteo regalis* | C2 | NL |
| Interior least tern[b] | *Sterna antillerum athalassos* | E | E |
| Loggerhead shrike[d] | *Lanius ludovicianus* | C2 | NL |
| Mountain plover | *Charadrius montanus* | C1 | NL |
| Western snowy plover | *Charadrius alexandrinus nivosus* | C2 | NL |
| White-faced ibis[d] | *Plegadis chihi* | C2 | T |
| Whooping crane[b,d] | *Grus americana* | E | E |
| **Reptiles** | | | |
| Smooth green snake | *Ophedorys vernalis* | NL | E |
| Texas garter snake | *Thamnophis sirtalis annectans* | C2 | NL |
| Texas horned lizard[d] | *Phrynosoma cornutum* | C2 | T |

[a] Status codes: C1 - candidate Category 1 (appropriate to list); C2 - candidate Category 2 (possibly appropriate to list); E - endangered; NL - not listed; T - threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Believed extirpated from Texas.

[d] Species observed on Pantex Plant.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; PX 1994a:1; PX DOE 1994b; PX MH 1994c; PX PWD 1991b; PX PWD 1993a; PX PWD 1993b; PX WTS 1992a.

**TABLE C–6.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Savannah River Site* [Page 1 of 2]**

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Mammals** | | | |
| Southern Appalachian eastern woodrat | *Neotoma floridana haematoreia* | C2 | UN |
| Rafinesque's big-eared bat | *Plecotus refinesquii* | C2 | SE |
| Star-nosed mole | *Condylura cristata parva* | NL | UN |
| Swamp rabbit | *Sylvilagus aquaticus* | NL | UN |
| **Birds** | | | |
| American peregrine falcon[b] | *Falco peregrinus anatum* | E | SE |
| Arctic peregrine falcon | *Falco peregrinus tundrius* | T | ST |
| Bachman's sparrow | *Aimophila aestivalis* | C2 | NL |
| Bald eagle[b] | *Haliaeetus leucocephalus* | E | SE |
| Bewick's wren | *Thyromanes bewickii altus* | C2 | ST |
| Cooper's hawk[c] | *Accipiter cooperii* | NL | UN |
| Loggerhead shrike | *Lanius ludovicianus* | C2 | NL |
| Mississippi kite | *Ictinia mississippiensis* | NL | UN |
| Osprey | *Pandion haliaetus* | NL | SC |
| Red-cockaded woodpecker[b] | *Picoides borealis* | E | SE |
| Red-headed woodpecker | *Melanerpes erythrocephalus* | NL | SC |
| Wood stork[b,d] | *Mycteria americana* | E | SE |
| **Reptiles** | | | |
| American alligator | *Alligator mississippiensis* | T | NL |
| Carolina swamp snake | *Seminatrix pygaea* | NL | UN |
| Eastern coral snake | *Micrurus fulvius fulvius* | NL | UN |
| Northern pine snake | *Pituophis melanoleucus melanoleucus* | C2 | NL |
| Southern hognose snake | *Heterodon simus* | C2 | NL |
| Spotted turtle | *Clemmys guttata* | NL | UN |
| **Amphibians** | | | |
| Carolina crawfish frog | *Rana areolata capito* | C2 | SC |
| Eastern bird-voiced treefrog | *Hyla avivoca ogechiensis* | NL | UN |
| Eastern tiger salamander[d] | *Ambystoma tigrinum tigrinum* | NL | SC |
| Pickerel frog[d] | *Rana palustris* | NL | UN |
| Upland chorus frog | *Pseudacris triseriata feriarum* | NL | SC |
| **Fishes** | | | |
| Bighead (Savannah) redhorse | *Moxostoma sp.* | C2 | NL |
| Shortnose sturgeon[b,d] | *Acipenser brevirostrum* | E | SE |
| **Invertebrates** | | | |
| American sandburrowing mayfly | *Dolania americana* | C2 | NL |
| Brother spike mussel | *Elliptio fraterna* | NL | SE |
| **Plants** | | | |
| Awned meadow-beauty[c] | *Rhexia aristosa* | C2 | NL |
| Beak-rush[d] | *Rhynchospora inundata* | NL | UN |
| Beak-rush[d] | *Rhynchospora tracyi* | NL | UN |
| Bog spice bush | *Lindera subcoriacea* | C2 | RC |

**TABLE C–6.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found On the Site or In the Vicinity of Savannah River Site* [Page 2 of 2]**

| Common Name | Scientific Name | Status[a] | |
|---|---|---|---|
| | | Federal | State |
| **Plants** (continued) | | | |
| Cypress stump sedge[d] | *Carex decomposita* | NL | UN |
| Dwarf bladderwort | *Utricularia olivacea* | NL | SL |
| Elliott's croton | *Croton elliottii* | NL | UN |
| Few-fruited sedge | *Carex oligocarpa* | NL | UN |
| Florida bladderwort | *Utricularia floridana* | NL | SL |
| Florida false loosestrife[c] | *Ludwigia spathulata* | NL | UN |
| Gaura | *Gaura biennis* | NL | UN |
| Green-fringed orchid[c] | *Platanthera lacera* | NL | SL |
| Leafy pondweed | *Potamogeton foliosus* | NL | UN |
| Little bur-head | *Echinodorus tenellus* | NL | SL |
| Loose water-milfoil | *Myriophyllum laxum* | C2 | RC |
| Milk-pea | *Astragalus villosus* | NL | UN |
| Nailwort | *Paronychia americana* | NL | UN |
| Nestronia | *Nestronia umbellula* | C2 | NL |
| Nutmeg hickory | *Carya myristiciformis* | NL | RC |
| Oconee azalea | *Rhododendron flammeum* | NL | SL |
| Pink tickseed | *Coreopsis rosea* | NL | RC |
| Quill-leaved swamp potato | *Sagittaria isoetiformis* | NL | SL |
| Sandhill lily | *Nolina georgiana* | NL | UN |
| Smooth purple coneflower | *Echinacea laevigata* | E | NC |
| Swamp lobelia | *Lobelia boykinii* | C2 | NL |
| Trepocarpus | *Trepocarpus aethusae* | NL | UN |
| Wild water-celery | *Vallisneria americana* | NL | UN |
| Yellow cress | *Rorippa sessiliflora* | NL | UN |
| Yellow porilla | *Menispermum canadense* | NL | UN |
| Yellow wild indigo | *Baptisia lanceolata* | NL | UN |

[a] Status codes: C2 - candidate Category 2 (possibly appropriate to list); E - endangered; NC - national, of concern, (plant); NL - not listed; PE - proposed endangered; RC - region, of concern, (plants); SC - state, of concern, (animals); SE - state, endangered (animals); SL - state, of concern, (plants); ST - state, threatened (animals); T - threatened; UN - undetermined.

[b] USFWS Recovery Plan exists for this species.

[c] Species known to occur near Rainbow bay adjacent to proposed tritium supply site.

[d] Species occurs in discharge receiving areas.

Source: 50 CFR 17.11; 50 CFR 17.12; 55 FR 6184; 56 FR 58804; 56 FR 64229; DOE 1994g; SR NERP 1990b; SR WMRD 1991a; SR WMRD 1991b; SR WMRD 1992a; SR WMRD 1992b; WSRC 1989e.

# APPENDIX D

# Appendix D

# APPENDIX D: SOCIOECONOMICS

## D.1 INTRODUCTION

This appendix includes the methodologies, models, assumptions, and supporting data used for assessing potential impacts in the socioeconomics sections of this Programmatic Environmental Impact Statement (PEIS). Section D.2 presents the methods and assumptions used to evaluate the potential socioeconomic effects of the proposed siting of tritium supply technologies and recycling facilities. The socioeconomic analysis involved two major steps: (1) the characterization and projection of existing social, economic, and infrastructure conditions surrounding each of the candidate sites (i.e., the affected environment); and (2) the evaluation of potential changes in socioeconomic conditions that could result from the construction and operation of tritium supply technologies and recycling facilities in the regions addressed (i.e., the environmental consequences). Supporting data for the affected environment and environmental consequences sections are presented in tables contained entirely at the end of the text in section D.3.

## D.2 METHODOLOGIES AND MODELS

### D.2.1 Employment and Population

The description of socioeconomic conditions includes indicators, such as population, civilian labor force, employment, unemployment rate, and income, that provide a basis for comparing regional socioeconomic conditions among the sites with No Action and with the various alternatives. The No Action alternative was considered equivalent to future baseline conditions without new activities. The baseline for the No Action alternative was established from the total employment projected for each of the sites at the end of fiscal year 1994. These proposed fiscal year 1994 budget and employment estimates were provided by each site and are believed to best reflect the staffing levels needed as a result of recent stockpile requirement reductions. Table D.2.1–1 presents historical employment and future employment projections for each site.

**Region-of-Influence and Economic Study Area.** For each site, socioeconomic impacts were estimated using two geographic areas. First, a region-of-influence (ROI) was identified based on the distribution of residences for current Department of Energy (DOE) and contractor personnel working at each of the proposed sites. The ROIs were determined to be those areas in which approximately 90 percent of the current DOE and contractor employees reside, and counties in which at least 5 percent of the DOE workforce lives. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site, and was used to estimate the future distribution of direct workers associated with the proposed alternatives.

As an example, table D.3–1 displays the residential distribution by city and county for all personnel employed at the Idaho National Engineering Laboratory (INEL). Data on residential location for a large portion of facility employees were obtained from

**TABLE D.2.1–1.—*Historical and Projected Site Employment***

| Site | 1970 | 1990 | 1992 | 1994 | 2005 | 2010 |
|---|---|---|---|---|---|---|
| INEL | 6,755 | 11,100 | 11,600 | 10,100 | 10,100 | 10,100 |
| NTS | 6,840 | 8,019 | 7,696 | 6,850 | 6,850 | 6,850 |
| ORR | 14,257 | 15,273 | 16,238 | 15,000 | 15,000 | 15,000 |
| Pantex Plant | 1,630 | 2,394 | 2,681 | 3,400 | 1,790 | 1,790 |
| SRS | 5,737 | 22,290 | 21,823 | 20,300 | 16,900 | 16,900 |

Source: DOE 1994e; INEL 1991a:6; NTS 1990a:3; NTS 1991a:1; NTS 1992a:7; NTS 1994a:1; ORR 1991a:4; ORR 1993a:8; ORR 1994a:1; PX 1991a:5; PX 1993a:2; PX MH 1994a; PX MH 1994b; PX MH 1994c; SRS 1992a:9; SRS 1993a:3; SRS 1994a:3.

INEL personnel offices. Similar data were provided by the other locations and are given in tables D.3–21, D.3–37, D.3–52, and D.3–72.

A second geographical area, referred to as a regional economic study area, was also identified for estimating socioeconomic impacts. The economic study area is a 50-mile radius around each site that encompasses a broad market that involves trade among and between regional industrial and service sectors and which is characterized by strong economic linkages between the communities located in the region. These linkages determine the nature and magnitude of multiplier effects of economic activity at each candidate site. The economic study area is used to analyze the primary economic impacts on employment, spending, earnings, and personal income. Table D.2.1–2 displays the counties found in each site's economic study area. As an example, later in this appendix table D.3–2 displays the employment, civilian labor force, unemployment rate, and personal and per capita incomes for the INEL economic study area. Similar data were provided by other locations and are given in tables D.3–22, D.3–38, D.3–53, and D.3–73. Impacts on employment from alternatives compared to No Action during construction and operation are given in tables D.3–3, D.3–4, D.3–23, D.3–24, D.3–39, D.3–40, D.3–54, D.3–55, and D.3–74.

**Existing and Future Baseline.** Historical and existing population, labor force, employment, and income data were obtained from the U.S. Bureau of Economic Analysis Regional Economic Information Systems. Historical personal income and per capita income values were converted to constant 1992 dollars using the current Department of Commerce National Income deflator index. Employment by place of work was converted to employment by place of residence on the basis of ratios derived from Bureau of Census, Bureau of Labor Statistics, and Bureau of Economic Analysis data.

Growth projections for population, labor force, employment, and income were based on Bureau of Economic Analysis Regional Projections to 2040 for Bureau of Economic Analysis economic regions and metropolitan statistical areas. Bureau of Economic Analysis projections are for multi-county economic regions or whole metropolitan statistical areas; therefore, projections for individual counties were made by applying the appropriate growth rates for each Bureau of Economic Analysis data series (population, employment, etc.) to each county in the identified ROI for each site. Data series forecasts for counties within a metropolitan statistical area were based on the higher Bureau of Economic Analysis growth rates projected for metropolitan areas, while forecasts for other counties in the ROI were based on generally lower regional growth projections.

**TABLE D.2.1–2.—*Counties Representing the Candidate Sites' Economic Study Areas***

| INEL | NTS | ORR | | Pantex | SRS | |
|---|---|---|---|---|---|---|
| **Idaho** | **California** | **Kentucky** | **Tennessee (continued)** | **Texas** | **Georgia** | **South Carolina** |
| Bannock | Inyo | Bell | Grainger | Armstrong | Bulloch | Aiken |
| Bingham | | McCreary | Hamblen | Bricoe | Burke | Allendale |
| Blaine | **Nevada** | Wayne | Jefferson | Carson | Columbia | Bamberg |
| Bonneville | Clark | Whitley | Knox | Castro | Effingham | Barnwell |
| Butte | Lincoln | | Loudon | Deaf Smith | Emanuel | Calhoun |
| Clark | Nye | **North Carolina** | McMinn | Donley | Glascock | Colleton |
| Custer | | Graham | Meigs | Gray | Jefferson | Edgefield |
| Fremont | | Swain | Monroe | Harley | Jenkins | Greenwood |
| Jefferson | | | Morgan | Hutchinson | Lincoln | Hampton |
| Lemhi | | **Tennessee** | Overton | Moore | McDuffie | Jasper |
| Madison | | Anderson | Putnam | Oldham | Richmond | Lexington |
| Minidoka | | Bledsoe | Rhea | Potter | Screven | Orangeburg |
| Power | | Blount | Roane | Randall | Warren | Saluda |
| | | Campbell | Scott | Roberts | | |
| | | Claiborne | Sevier | Swisher | | |
| | | Cumberland | Union | | | |
| | | Fentress | | | | |

Source: McNalley 1985a; USGS 1972a.

**Potential Project Effects.** Total output multipliers for each region were obtained from the U.S. Department of Commerce, Bureau of Economic Analysis Regional Inter-industry Multiplier System, and utilized in an economic model developed for evaluation of socioeconomic impacts of large-scale government programs.

The model includes four major components for the analysis:

- Regional inter-industry component that produced a regional input-output table and output multipliers for each specified sector of the economy for each economic study area.

- Direct effects component that produced a matrix of final demands (estimated changes in industry and household spending due to project activities) on the basis of direct employment and procurement associated with the project.

- Employment impact component that calculated region-wide indirect output, earnings, and employment estimates.

- Macroeconomic impact component that calculated regional population impacts on the basis of assumptions concerning possible changes in unemployment, the share of the labor force with the necessary skills to take direct project jobs, and the portion of the direct employment that would in-migrate to the ROI.

These inter-industry multipliers were estimated using the Bureau's input-output table for the United States in combination with the most recent region-specific information describing the relationship of the regional economy to the national economy.

The same methodology was used to develop quantitative projections of economic activity for No Action conditions and the alternatives. Project-related changes in regional demand in each local industrial and household sector were first estimated as follows:

- Construction-phase demands were based on construction labor and cost data provided by Fluor-Daniel, Inc., engineers, and the DOE sites affected by the proposal from parameters developed in support of the description of alternatives development.

- Operation-phase demands were estimated from data provided by Fluor Daniel, Inc. and DOE operations employment estimates and procurement requirements from existing DOE facilities that provide similar manufacturing activities.

The direct effects component uses the construction and operations demand to determine the procurement in the specific industries and the personal consumption expenditures (household spending) due to the project activities, taking into consideration the disposable income of each type of direct employment category.

These primary or direct effects were then multiplied, using Regional Inter-industry Multiplier System coefficients specific to the regional economy, to provide estimated total spending associated with the alternatives. Input-output sectors were selected to reflect the anticipated spending profile associated with the alternatives in order to capture the economic characteristics of each scenario within the economic study area. The employment impact component thus estimates the indirect employment, earnings, and personal income due to the alternatives. Table D.2.1–3 presents the assumptions for direct and indirect employment that were used for the regional socioeconomic analysis.

The macroeconomic impact component uses the information regarding the direct and indirect employment from the direct effects and employment impact components, as well as the baseline information, to estimate the direct and indirect employment that would in-migrate into the ROI. Numbers of in-migrant workers associated with each alternative were estimated according to a set of assumptions concerning the availability of required labor skill levels within each regional labor force and the recognition that competitive bidding for both construction and operations activities would bring in a certain number of workers regardless of available labor. For smaller demands of construction and operations activities as compared to regional labor availability,

**TABLE D.2.1–3.—*Assumptions for Economic Study Area***

| Employment | Category | | | |
|---|---|---|---|---|
| | PRDEP | HHS | FF | NLOC |
| **Direct** | | | | |
| ***Construction*** | | | | |
| Direct | 0.238[a] | 3.11[b] | 0.589[b] | 0.25 |
| Support | 0.238[a] | 2.93[b] | 0.618[b] | 0.75 |
| ***Operation*** | | | | |
| DOE operations | 0.247[a] | 3.17[c] | 0.708[c] | 0.50 |
| **Indirect** | | | | |
| Personal consumption | | 3.17[c] | 0.708[c] | |
| Procurement | | 3.17[c] | 0.708[c] | |
| Related investment | | 3.17[c] | 0.708[c] | |

[a] CEA 1992a; OWRC 1975a.
[b] USCOE 1981a.
[c] DOC 1991a.
Note: PRDEP - Labor force participation rate of the dependents of in-migrating workforce; HHS - Household size of workers accompanied by dependents; FF - Fraction of workers accompanied by dependents; NLOC - Proportion of workers assumed to be non-local.

in-migrant workers were primarily associated with contract award relocation assumptions. In addition to analyzing the population changes due to in-migrant workers, population changes due to out-migrations of workers from sites that would have workforce reductions as a result of the phasing out missions were examined. These population projections are conservative because they are estimated under the assumption that all the jobs lost will occur in the single year 2010.

Average household sizes for in-migrant workers were assumed to correspond, for most categories, with the average size of state-to-state migrating families between 1980 and 1990. The intra-regional allocation analysis accounts for the distribution of direct and indirect workers and their families among the various residential areas within each region. The direct effect portion of the allocation process accounts for the two main factors affecting the distribution of in-migrant direct workers: (1) the number of workers anticipated to be directly involved with each alternative and (2) the locations and relative attractiveness of residential opportunities within the region. Analytic methods are basically similar for assessing both population increases due to in-migration of direct and indirect workers and their families and population decreases due to out-migration of direct and indirect workers and their families.

Population changes associated with the alternatives are an important determinant of other socioeconomic and environmental impacts. These population changes have three key components: (1) baseline growth; (2) relocation of workers and their dependents; and (3) natural increase of population (births minus deaths) over the long term. To evaluate anticipated population effects, potential future changes associated with the tritium supply technologies and recycling facilities were compared to projected baseline conditions.

The computer output of the macroeconomic impact component for INEL is presented in table D.2.1–4. The first page of the table presents the employment and population parameter values used for this analysis and baseline and project information. The second page presents direct and indirect project impacts and a summary of effects for the year 2001. Similar output was created for all project years through 2010. Table D.3–2 is a summary of the employment and local economy results for INEL for selected years between 1970 and 2020. Population and economic data for all the sites are given in tables D.3–5, D.3–25, D.3–41, D.3–56, and D.3–75. Impacts on population from the alternatives compared to No Action during construction and operation are given in tables D.3–6, D.3–7, D.3–26, D.3–27, D.3–42, D.3–43, D.3–57, D.3–58, and D.3–76.

TABLE D.2.1–4.—*Parameters Used by the Model Idaho National Engineering Laboratory Example* [Page 1 of 2]

**Parameters Used By the Model**
MSLF = .1000 FUR = .0428

**Direct Employment Parameters**

| Category | DSHARE | DUR | PRDEP | DURDEP | HHS | FF | DCIV | NLNOTR | NLRLOC | SHWCOM |
|---|---|---|---|---|---|---|---|---|---|---|
| Construction-direct | .082 | .043 | .238 | .043 | 3.110 | .589 | 1.000 | .000 | .250 | .000 |
| Construction-support | .014 | .043 | .238 | .043 | 2.930 | .618 | 1.000 | .000 | .750 | .000 |
| DOE operations | .089 | .043 | .247 | .043 | 3.170 | .708 | 1.000 | .000 | .500 | .000 |

**Indirect Employment Parameters**

| Category | IUR | HHS | FF |
|---|---|---|---|
| Personal consumption | .043 | 3.170 | .708 |
| Procurement | .043 | 3.170 | .708 |
| Related investment | .043 | 3.170 | .708 |

**Logistic Labor Force Response Parameters**

Proportion of population that is of working age = 0.643
Beta parameter of effect of project jobs on labor force participation (0 = no effect) = 0.0000

**Year: 2001**

| **Baseline Information** | |
|---|---|
| Population | 286,010 |
| Civilian labor force | 140,059 |
| Labor force participation rate (w/o project.) | .4897 |
| Employed civilian labor force (w/o project.) | 131,039 |
| Unemployment rate | .064 |
| Total employment (w/o project.) | 131,043 |
| Earnings ($1,000) | 3,351,102 |
| Personal income ($1,000) | 4,703,569 |
| Per capita income (w/o project.) | 16,445 |

**Project Information**

| Employment Category | Direct Employment | Earnings ($1,000) | Personal Income ($1,000) |
|---|---|---|---|
| Construction-direct | 297.0 | 6,821 | 6,821 |
| Construction-support | 45.0 | 2,115 | 2,115 |
| DOE operations | 0.0 | 0.0 | 0.0 |
| **Subtotal** | 342.0 | 8,937 | 8,937 |
| **Indirect Employment** | | | |
| Personal consumption | 108.3 | 3,115 | 4,372 |
| Procurement | 516.2 | 18,864 | 26,477 |
| Related investment | 0.0 | 0.0 | 0.0 |
| **Subtotal** | 624.5 | 21,979 | 30,849 |
| Total-place of work | 966.5 | 30,915 | 39,786 |
| Weekly commuting adjustment | | | 0.0 |
| Total-place of residence | | | 39,786 |

**Direct and Indirect Project Impacts**
**Direct Employment Category**

| Category | Available Residential Labor Force | Excess Demand | Labor Force Increase | Dependents | Population Impacts | Weekly Commuters | Accompanying Labor Force |
|---|---|---|---|---|---|---|---|
| Construction-direct | 248.07 | 74.25 | 77.57 | 96.40 | 173.97 | .00 | 22.94 |
| Construction-support | 42.35 | 33.75 | 35.26 | 42.05 | 77.31 | .00 | 10.01 |
| DOE operations | 269.25 | .00 | .00 | .00 | .00 | .00 | .00 |
| **Subtotal** | **559.68** | **108.00** | **112.83** | **138.46** | **251.29** | **.00** | **32.95** |

**TABLE D.2.1–4.—*Parameters Used by the Model Idaho National Engineering Laboratory Example* [Page 2 of 2]**

**Indirect Employment Category**

| Category | Demand Share of Available Residential Labor Force | Excess Demand | Labor Force Increase | Dependents | Population Impacts | Labor Force Share |
|---|---|---|---|---|---|---|
| Personal consumption | 427.57 | .00 | .00 | .00 | .00 | .14 |
| Procurement | 2,038.03 | .00 | .00 | .00 | .00 | .67 |
| Related investment | .00 | .00 | .00 | .00 | .00 | .00 |
| **Subtotal** | **2,465.60** | **.00** | **.00** | **.00** | **.00** | **.81** |
| **Total** | **3,025.28** | **108.00** | **112.83** | **138.46** | **251.29** | **33.76** |

**Summary of Effects**

| | | |
|---|---|---|
| Employment: | Direct employment (all categories) | 342 |
| | Indirect employment (all categories) | 624 |
| | Total project-related employment | 966 |
| | Project-related civilian employment | 966 |
| | Civilian labor force increase | 146 |
| | Civilian labor force (w/project) | 140,205 |
| | Employed civilian labor force (w/project) | 132,006 |
| | Unemployment rate (w/project) | .058 |
| | Total employment (w/project) | 132,009 |
| | Adjusted baseline labor force participation rate (w/project) | .4897 |
| | Labor force partic. rate (w/project) | .4898 |
| | Maximum employment of accompanying labor force | 32 |
| Population: | Total population impact | 251 |
| | Total population (w/project) | 286,261 |
| | Direct weekly commuters | 0.00 |
| Income: | Direct project-related earnings ($1,000) | 8,937 |
| | Direct project-related resident earnings ($1,000) | 8,937 |
| | Indirect project-related earnings ($1,000) | 21,979 |
| | Earnings (w/project $1,000) | 3,382,017 |
| | Personal income impact of project ($1,000) | 39,786 |
| | Personal income (w/project $1,000) | 4,743,355 |
| | Per capita income (w/project) | 16,570 |

**Abbreviations**

DCIV - Fraction of direct employment which can be filled by civilians.
DSHARE - Employable share of available resident labor force.
DUR - Unemployment rate, in-migrant workers (Direct employment).
DURDEP - Unemployment rate, dependents of in-migrant workers.
FF - Fraction of workers accompanied by dependents.
FUR - Floor value for minimum unemployment rate.
HHS - Household size, workers accompanied by dependents.
IUR - Unemployment rate, in-migrant workers (indirect employment).
MSLF - Maximum share of baseline labor force employed with project - but unemployed without it.
NLNOTR - Share of employment assumed to be non-local, and not relocating from out of region.
NLRLOC - Share of employment assumed to be non-local, but relocating from out of region.
PRDEP - Labor force participation rate, dependents of in-migrant workers.
SHWCOM - Share of direct workers who are weekly commuters.

Source: CEA 1992a; Census 1972a; Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOC 1993a; OWRC 1975a; USCOE 1981a; IN Census 1991a; IN DOC 1991a.

### D.2.2 Housing

Baseline housing characteristics are presented in tables D.3–8, D.3–28, D.3–44, D.3–59, and D.3–77. Projected housing needs are based upon housing unit and population data obtained from the *1990 Census of Population and Housing* for each ROI. Future housing units needed for cities and counties in each ROI were developed by estimating the household size from the current population and housing unit ratios. The household size-to-population ratios were then applied to the estimated future population trends to obtain the number of housing units needed to accommodate the projected population for a No Action alternative future baseline.

Projected housing needs for the alternatives were developed in the same manner as the estimates for a No Action baseline. These estimates, however, include projected in-migrating workforces (and their families) from outside the ROI. Future housing needs for the in-migrating populations, resulting from employment created directly or indirectly by the project, were estimated from the national average household size from the *1990 Census of Population and Housing* for each ROI. Conversely, estimates of additional housing unit vacancies created directly and indirectly by a project alternative as a result of out-migrations were developed from current population and household size ratios. Impacts on housing from the alternatives compared to No Action during construction and operation are given in tables D.3–9, D.3–10, D.3–29, D.3–30, D.3–45, D.3–46, D.3–60, D.3–61, and D.3–78.

### D.2.3 Public Finance

Finances of ROI local jurisdictions were evaluated based on changes in historic revenue and expenditure levels, changes in fund balances, and reserve bonding capabilities. These historic fiscal characteristics were obtained from financial audits and budgets supplied by each jurisdiction. The analysis concentrated on each jurisdiction's governmental funds (general funds, special revenue funds, and, as applicable, capital projects, debt service, and expendable trust funds). Other funds, such as enterprise funds, which are funded principally through user charges without contributing to the general tax burden of area residents, were not included in the analyses.

The analysis of local jurisdictions' public finances focussed upon revenues and expenditures because no assumptions could be made for some projected fund balances (such as capital expenditures) so far into the future.

The following parameters were used to project changes in total revenues and expenditures: gains (or losses) of jobs in the region; population increases (or decreases) in each jurisdiction, including school districts; earnings and income gains (or losses); and potential changes in each jurisdiction's property tax base. Public finance characteristics are presented in tables D.3–11, D.3–12, D.3–31, D.3–32, D.3–47, D.3–62, D.3–63, D.3–79, and D.3–80. Impacts on public finance from the alternatives compared to No Action during construction and operation are given in tables D.3–13 through D.3–20, D.3–33 through D.3–36, D.3–48 through D.3–51, D.3–64 through D.3–71, and D.3–81 through D.3–84.

### D.2.4 Local Transportation

Local transportation impacts are qualitatively assessed in terms of the changes to roadway traffic volumes and service levels associated with tritium supply technologies and recycling activities employment and area population changes.

## D.3 Supporting Data

Data and analyses used to support the assessments made for the socioeconomics section are presented in the following tables.

**TABLE D.3–1.—*Distribution of Employees by Place of Residence for Idaho National Engineering Laboratory, 1991***

| County/City | Number of Employees | Total Site Employment (percent) |
|---|---|---|
| Bannock County | 342 | 5.3 |
| Pocatello | 317 | 4.9 |
| Bingham County | 576 | 8.9 |
| Blackfoot | 460 | 7.1 |
| Bonneville County | 4,893 | 75.7 |
| Idaho Falls | 4,750 | 73.5 |
| Butte County | 123 | 1.9 |
| Jefferson County | 419 | 6.5 |
| Rigby | 320 | 4.9 |
| **Total ROI (County)** | 6,353 | 98.3 |

Note: Data on Westinghouse Electric Company employees were not available and is not included. Butte County was included in the ROI because more than one half of INEL is located within the county.

Source: INEL 1991a:6.

**TABLE D.3–2.—*Employment and Local Economy Statistics for Idaho National Engineering Laboratory Economic Study Area, 1970-2020***

| Economic Study Area | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Civilian labor force | 84,030 | 118,852 | 128,517 | 151,249 | 154,226 | 150,521 |
| Total employment | 79,028 | 110,805 | 120,242 | 141,510 | 144,295 | 140,829 |
| Unemployment rate (percent) | 6.0 | 6.8 | 6.4 | 6.4 | 6.4 | 6.4 |
| Personal income (thousand dollars) | 682,703 | 2,176,049 | 4,175,612 | 5,458,323 | 5,850,853 | 6,488,596 |
| Per capita income (dollars per person) | 3,309 | 8,214 | 14,824 | 18,569 | 19,565 | 20,903 |

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; IN DOC 1991a.

**TABLE D.3–3.—*Changes to Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Idaho National Engineering Laboratory Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 141,510 | 148,066 | 4.63 | 147,755 | 4.41 | 151,400 | 6.99 | 145,325 | 2.70 | 142,346 | 1.38 |
| Unemployment rate (percent) | 6.4 | 4.5 | NA | 4.5 | NA | 4.5 | NA | 4.8 | NA | 5.5 | NA |
| Per capita income (dollars per person) | 18,569 | 18,923 | 1.91 | 18,929 | 1.94 | 18,860 | 1.57 | 18,892 | 1.74 | 18,371 | 1.02 |
| **Operation** | | | | | | | | | | | |
| Total employment | 144,295 | 146,787 | 1.73 | 146,733 | 1.69 | 146,519 | 1.54 | 145,967 | 1.16 | 145,967 | 1.16 |
| Unemployment rate (percent) | 6.4 | 5.4 | NA | 5.4 | NA | 5.5 | NA | 5.6 | N/A | 5.6 | N/A |
| Per capita income (dollars per person) | 19,565 | 19,804 | 1.22 | 19,800 | 1.20 | 19,784 | 1.12 | 19,742 | 0.91 | 19,742 | 0.91 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN DOC 1991a.

**TABLE D.3–4.—*Changes to Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 141,510 | 149,012 | 5.30 | 148,701 | 5.08 | 152,346 | 7.66 | 146,271 | 3.36 | 143,293 | 2.05 |
| Unemployment rate (percent) | 6.4 | 4.5 | NA | 4.5 | NA | 4.5 | NA | 4.5 | NA | 4.5 | NA |
| Per capita income (dollars per person) | 18,569 | 18,905 | 1.81 | 18,911 | 1.84 | 18,842 | 1.47 | 18,959 | 2.10 | 18,443 | 1.42 |
| **Operation** | | | | | | | | | | | |
| Total employment | 144,295 | 149,225 | 3.42 | 149,172 | 3.38 | 148,957 | 3.23 | 148,405 | 2.85 | 148,405 | 2.85 |
| Unemployment rate (percent) | 6.4 | 4.6 | NA | 4.6 | NA | 4.7 | NA | 4.9 | N/A | 4.9 | N/A |
| Per capita income (dollars per person) | 19,565 | 19,984 | 2.14 | 19,980 | 2.12 | 19,964 | 2.04 | 19,924 | 1.84 | 19,924 | 1.84 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN DOC 1991a.

**TABLE D.3–5.—*Population for Idaho National Engineering Laboratory Region-of-Influence, 1970-2020***

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Bannock County | 52,200 | 65,421 | 66,026 | 69,515 | 70,721 | 73,409 |
| Pocatello | 40,036 | 43,340 | 46,080 | 48,515 | 49,357 | 51,232 |
| Bingham County | 29,167 | 36,489 | 37,583 | 39,449 | 40,133 | 41,658 |
| Blackfoot | 8,716 | 10,065 | 9,646 | 10,125 | 10,301 | 10,692 |
| Bonneville County | 52,457 | 65,980 | 72,207 | 74,420 | 75,711 | 78,588 |
| Idaho Falls | 35,776 | 39,590 | 43,929 | 45,275 | 46,061 | 47,811 |
| Butte County | 2,925 | 3,342 | 2,918 | 3,199 | 3,254 | 3,378 |
| Jefferson County | 11,740 | 15,304 | 16,543 | 17,166 | 17,463 | 18,127 |
| Rigby | 2,324 | 2,624 | 2,681 | 2,782 | 2,830 | 2,938 |
| **Total ROI** | 148,489 | 186,536 | 195,277 | 203,749 | 207,282 | 215,159 |

Source: Census 1973a; Census 1977a; Census 1983a; IN Census 1991a.

TABLE D.3–6.—*Changes to Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Idaho National Engineering Laboratory Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Bannock County | 69,515 | 69,908 | 0.57 | 69,870 | 0.51 | 70,315 | 1.15 | 69,646 | 0.19 | 69,089 | 0.07 |
| Pocatello | 48,515 | 48,879 | 0.75 | 48,844 | 0.68 | 49,255 | 1.53 | 48,636 | 0.25 | 48,229 | 0.10 |
| Bingham County | 39,449 | 40,109 | 1.67 | 40,045 | 1.51 | 40,792 | 3.40 | 39,668 | 0.56 | 39,262 | 0.21 |
| Blackfoot | 10,125 | 10,652 | 5.20 | 10,601 | 4.70 | 11,197 | 10.59 | 10,300 | 1.73 | 10,122 | 0.66 |
| Bonneville County | 74,420 | 80,036 | 7.55 | 79,494 | 6.82 | 85,845 | 15.35 | 76,287 | 2.51 | 74,623 | 0.97 |
| Idaho Falls | 45,275 | 50,728 | 12.04 | 50,202 | 10.88 | 56,369 | 24.50 | 47,088 | 4.00 | 45,658 | 1.54 |
| Butte County | 3,199 | 3,339 | 4.38 | 3,326 | 3.97 | 3,485 | 8.94 | 3,245 | 1.44 | 3,195 | 0.58 |
| Jefferson County | 17,166 | 17,648 | 2.81 | 17,601 | 2.53 | 18,147 | 5.71 | 17,326 | 0.93 | 17,109 | 0.36 |
| Rigby | 2,782 | 3,145 | 13.05 | 3,110 | 11.79 | 3,521 | 26.56 | 2,902 | 4.31 | 2,809 | 1.67 |
| **Total ROI Construction** | 203,749 | 211,040 | 3.58 | 210,336 | 3.23 | 218,584 | 7.28 | 206,172 | 1.19 | 203,278 | 0.46 |
| **Operation** | | | | | | | | | | | |
| Bannock County | 70,721 | 70,812 | 0.13 | 70,809 | 0.12 | 70,797 | 0.11 | 70,768 | 0.07 | 70,768 | 0.07 |
| Pocatello | 49,357 | 49,441 | 0.17 | 49,438 | 0.16 | 49,427 | 0.14 | 49,400 | 0.09 | 49,400 | 0.09 |
| Bingham County | 40,133 | 40,285 | 0.38 | 40,280 | 0.37 | 40,261 | 0.32 | 40,212 | 0.20 | 40,212 | 0.20 |
| Blackfoot | 10,301 | 10,422 | 1.18 | 10,418 | 1.14 | 10,403 | 0.99 | 10,364 | 0.62 | 10,364 | 0.62 |
| Bonneville County | 75,711 | 77,004 | 1.71 | 76,963 | 1.65 | 76,800 | 1.44 | 76,379 | 0.88 | 76,379 | 0.88 |
| Idaho Falls | 46,061 | 47,316 | 2.73 | 47,277 | 2.64 | 47,118 | 2.30 | 46,710 | 1.41 | 46,710 | 1.41 |
| Butte County | 3,254 | 3,286 | 0.98 | 3,285 | 0.95 | 3,281 | 0.83 | 3,271 | 0.52 | 3,271 | 0.52 |
| Jefferson County | 17,463 | 17,574 | 0.63 | 17,571 | 0.62 | 17,556 | 0.53 | 17,520 | 0.32 | 17,520 | 0.32 |
| Rigby | 2,830 | 2,914 | 2.96 | 2,911 | 2.86 | 2,900 | 2.47 | 2,873 | 1.51 | 2,873 | 1.51 |
| **Total ROI Operation** | 207,282 | 208,961 | 0.81 | 208,908 | 0.78 | 208,695 | 0.68 | 208,150 | 0.42 | 208,150 | 0.42 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN Census 1991a.

TABLE D.3–7.—*Changes to Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Bannock County | 69,515 | 70,024 | 0.73 | 69,986 | 0.68 | 70,431 | 1.32 | 69,689 | 0.25 | 69,129 | 0.13 |
| Pocatello | 48,515 | 48,986 | 0.97 | 48,950 | 0.90 | 49,362 | 1.75 | 48,676 | 0.33 | 48,267 | 0.18 |
| Bingham County | 39,449 | 40,303 | 2.16 | 40,239 | 2.00 | 40,986 | 3.90 | 39,741 | 0.74 | 39,331 | 0.39 |
| Blackfoot | 10,125 | 10,806 | 6.73 | 10,756 | 6.23 | 11,351 | 12.11 | 10,358 | 2.30 | 10,177 | 1.21 |
| Bonneville County | 74,420 | 81,685 | 9.76 | 81,142 | 9.03 | 87,495 | 17.57 | 76,908 | 3.34 | 75,206 | 1.75 |
| Idaho Falls | 45,275 | 52,329 | 15.58 | 51,803 | 14.42 | 57,971 | 28.04 | 47,692 | 5.34 | 46,224 | 2.80 |
| Butte County | 3,199 | 3,381 | 5.69 | 3,367 | 5.25 | 3,527 | 10.25 | 3,261 | 1.94 | 3,209 | 1.02 |
| Jefferson County | 17,166 | 17,789 | 3.63 | 17,743 | 3.36 | 18,288 | 6.54 | 17,379 | 1.24 | 17,159 | 0.65 |
| Rigby | 2,782 | 3,252 | 16.89 | 3,217 | 15.64 | 3,628 | 30.41 | 2,943 | 5.79 | 2,846 | 3.01 |
| **Total ROI Construction** | 203,749 | 213,182 | 4.63 | 212,477 | 4.28 | 220,727 | 8.33 | 206,978 | 1.58 | 204,034 | 0.83 |
| **Operation** | | | | | | | | | | | |
| Bannock County | 70,721 | 70,942 | 0.31 | 70,939 | 0.31 | 70,927 | 0.29 | 70,898 | 0.25 | 70,898 | 0.25 |
| Pocatello | 49,357 | 49,561 | 0.41 | 49,558 | 0.41 | 49,548 | 0.39 | 49,520 | 0.33 | 49,520 | 0.33 |
| Bingham County | 40,133 | 40,503 | 0.92 | 40,499 | 0.91 | 40,479 | 0.86 | 40,430 | 0.74 | 40,430 | 0.74 |
| Blackfoot | 10,301 | 10,596 | 2.87 | 10,593 | 2.84 | 10,577 | 2.68 | 10,538 | 2.31 | 10,538 | 2.31 |
| Bonneville County | 75,711 | 78,861 | 4.16 | 78,820 | 4.11 | 78,657 | 3.89 | 78,236 | 3.34 | 78,236 | 3.34 |
| Idaho Falls | 46,061 | 49,119 | 6.64 | 49,080 | 6.56 | 48,921 | 6.21 | 48,513 | 5.32 | 48,513 | 5.32 |
| Butte County | 3,254 | 3,333 | 2.43 | 3,332 | 2.40 | 3,328 | 2.27 | 3,317 | 1.93 | 3,317 | 1.93 |
| Jefferson County | 17,463 | 17,733 | 1.54 | 17,730 | 1.53 | 17,716 | 1.45 | 17,680 | 1.24 | 17,680 | 1.24 |
| Rigby | 2,830 | 3,034 | 7.20 | 3,031 | 7.10 | 3,021 | 6.74 | 2,993 | 5.75 | 2,993 | 5.75 |
| **Total ROI Operation** | 207,282 | 211,372 | 1.97 | 211,320 | 1.95 | 211,107 | 1.85 | 210,561 | 1.58 | 210,561 | 1.58 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN Census 1991a.

TABLE D.3–8.—*Total Housing Units for Idaho National Engineering Laboratory Region-of-Influence, 1970-2020*

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Bannock County | 16,516 | 24,819 | 25,694 | 27,052 | 27,521 | 28,567 |
| Pocatello | 12,849 | 18,462 | 18,768 | 19,760 | 20,103 | 20,866 |
| Bingham County | 8,429 | 12,084 | 12,664 | 13,293 | 13,523 | 14,037 |
| Blackfoot | 2,703 | 3,707 | 3,617 | 3,797 | 3,862 | 4,009 |
| Bonneville County | 15,683 | 23,492 | 26,049 | 26,847 | 27,313 | 28,351 |
| Idaho Falls | 11,364 | 15,053 | 16,845 | 17,361 | 17,662 | 18,334 |
| Butte County | 1,021 | 1,280 | 1,265 | 1,387 | 1,411 | 1,464 |
| Jefferson County | 3,488 | 4,994 | 5,353 | 5,554 | 5,651 | 5,866 |
| Rigby | 748 | 962 | 969 | 1,005 | 1,023 | 1,062 |
| **Total ROI** | 45,137 | 66,669 | 71,025 | 74,133 | 75,419 | 78,285 |

Source: Census 1972a; Census 1973a; Census 1977a; Census 1982a; Census 1983a; IN Census 1991a.

TABLE D.3–9.—*Changes in Housing Demand During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Idaho National Engineering Laboratory Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Bannock County | 27,052 | 27,201 | 0.55 | 27,187 | 0.50 | 27,356 | 1.12 | 27,102 | 0.18 | 26,886 | 0.07 |
| Pocatello | 19,760 | 19,898 | 0.70 | 19,885 | 0.63 | 20,041 | 1.42 | 19,806 | 0.23 | 19,642 | 0.09 |
| Bingham County | 13,293 | 13,544 | 1.89 | 13,519 | 1.71 | 13,803 | 3.84 | 13,376 | 0.63 | 13,233 | 0.24 |
| Blackfoot | 3,797 | 3,997 | 5.28 | 3,978 | 4.77 | 4,204 | 10.74 | 3,863 | 1.75 | 3,796 | 0.67 |
| Bonneville County | 26,847 | 28,983 | 7.95 | 28,777 | 7.19 | 31,191 | 16.18 | 27,557 | 2.64 | 26,934 | 1.02 |
| Idaho Falls | 17,361 | 19,435 | 11.94 | 19,235 | 10.79 | 21,579 | 24.30 | 18,050 | 3.97 | 17,506 | 1.53 |
| Butte County | 1,387 | 1,440 | 3.85 | 1,435 | 3.49 | 1,496 | 7.85 | 1,404 | 1.27 | 1,384 | 0.51 |
| Jefferson County | 5,554 | 5,738 | 3.30 | 5,720 | 2.98 | 5,928 | 6.72 | 5,615 | 1.10 | 5,540 | 0.42 |
| Rigby | 1,005 | 1,144 | 13.73 | 1,130 | 12.41 | 1,286 | 27.95 | 1,051 | 4.54 | 1,016 | 1.76 |
| **Total ROI Constrtuction** | 74,133 | 76,906 | 3.74 | 76,638 | 3.38 | 79,774 | 7.61 | 75,055 | 1.24 | 73,977 | 0.48 |
| **Operation** | | | | | | | | | | | |
| Bannock County | 27,521 | 27,556 | 0.13 | 27,555 | 0.12 | 27,550 | 0.10 | 27,539 | 0.06 | 27,539 | 0.06 |
| Pocatello | 20,103 | 20,135 | 0.16 | 20,133 | 0.15 | 20,129 | 0.13 | 20,119 | 0.08 | 20,119 | 0.08 |
| Bingham County | 13,523 | 13,581 | 0.43 | 13,579 | 0.41 | 13,572 | 0.36 | 13,553 | 0.22 | 13,553 | 0.22 |
| Blackfoot | 3,862 | 3,909 | 1.20 | 3,907 | 1.16 | 3,901 | 1.01 | 3,887 | 0.62 | 3,887 | 0.62 |
| Bonneville County | 27,313 | 27,805 | 1.80 | 27,789 | 1.74 | 27,727 | 1.52 | 27,567 | 0.93 | 27,567 | 0.93 |
| Idaho Falls | 17,662 | 18,140 | 2.70 | 18,125 | 2.62 | 18,064 | 2.28 | 17,909 | 1.40 | 17,909 | 1.40 |
| Butte County | 1,411 | 1,423 | 0.86 | 1,422 | 0.83 | 1,421 | 0.73 | 1,417 | 0.46 | 1,417 | 0.46 |
| Jefferson County | 5,651 | 5,693 | 0.74 | 5,692 | 0.72 | 5,686 | 0.62 | 5,672 | 0.38 | 5,672 | 0.38 |
| Rigby | 1,023 | 1,055 | 3.12 | 1,054 | 3.01 | 1,049 | 2.60 | 1,039 | 1.59 | 1,039 | 1.59 |
| **Total ROI Operation** | 75,419 | 76,057 | 0.85 | 76,037 | 0.82 | 75,956 | 0.71 | 75,749 | 0.44 | 75,749 | 0.44 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN Census 1991a.

TABLE D.3–10.—*Changes in Housing Demand During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Bannock County | 27,052 | 27,245 | 0.72 | 27,231 | 0.66 | 27,400 | 1.29 | 27,118 | 0.24 | 26,901 | 0.13 |
| Pocatello | 19,760 | 19,939 | 0.91 | 19,925 | 0.84 | 20,082 | 1.63 | 19,821 | 0.31 | 19,656 | 0.16 |
| Bingham County | 13,293 | 13,617 | 2.44 | 13,593 | 2.26 | 13,877 | 4.40 | 13,404 | 0.84 | 13,260 | 0.44 |
| Blackfoot | 3,797 | 4,056 | 6.82 | 4,037 | 6.32 | 4,263 | 12.28 | 3,885 | 2.33 | 3,817 | 1.23 |
| Bonneville County | 26,847 | 29,610 | 10.29 | 29,403 | 9.52 | 31,819 | 18.52 | 27,793 | 3.52 | 27,156 | 1.85 |
| Idaho Falls | 17,361 | 20,043 | 15.45 | 19,843 | 14.30 | 22,189 | 27.81 | 18,280 | 5.29 | 17,721 | 2.78 |
| Butte County | 1,387 | 1,456 | 5.00 | 1,451 | 4.62 | 1,512 | 9.01 | 1,410 | 1.71 | 1,389 | 0.89 |
| Jefferson County | 5,554 | 5,791 | 4.27 | 5,774 | 3.95 | 5,981 | 7.68 | 5,636 | 1.46 | 5,559 | 0.77 |
| Rigby | 1,005 | 1,184 | 17.78 | 1,171 | 16.45 | 1,327 | 32.00 | 1,067 | 6.09 | 1,030 | 3.17 |
| **Total ROI Construction** | 74,133 | 77,720 | 4.84 | 77,452 | 4.48 | 80,589 | 8.71 | 75,361 | 1.66 | 74,265 | 0.87 |
| **Operation** | | | | | | | | | | | |
| Bannock County | 27,521 | 27,605 | 0.31 | 27,604 | 0.30 | 27,599 | 0.28 | 27,588 | 0.24 | 27,588 | 0.24 |
| Pocatello | 20,103 | 20,180 | 0.39 | 20,179 | 0.38 | 20,175 | 0.36 | 20,165 | 0.31 | 20,165 | 0.31 |
| Bingham County | 13,523 | 13,664 | 1.04 | 13,662 | 1.03 | 13,655 | 0.97 | 13,636 | 0.83 | 13,636 | 0.83 |
| Blackfoot | 3,862 | 3,975 | 2.91 | 3,974 | 2.88 | 3,968 | 2.72 | 3,953 | 2.34 | 3,953 | 2.34 |
| Bonneville County | 27,313 | 28,511 | 4.39 | 28,495 | 4.33 | 28,433 | 4.10 | 28,273 | 3.52 | 28,273 | 3.52 |
| Idaho Falls | 17,662 | 18,825 | 6.58 | 18,810 | 6.50 | 18,750 | 6.16 | 18,595 | 5.28 | 18,595 | 5.28 |
| Butte County | 1,411 | 1,441 | 2.13 | 1,440 | 2.10 | 1,439 | 1.99 | 1,435 | 1.70 | 1,435 | 1.70 |
| Jefferson County | 5,651 | 5,753 | 1.81 | 5,752 | 1.79 | 5,747 | 1.70 | 5,733 | 1.46 | 5,733 | 1.46 |
| Rigby | 1,023 | 1,100 | 7.58 | 1,099 | 7.47 | 1,095 | 7.09 | 1,085 | 6.05 | 1,085 | 6.05 |
| **Total ROI Operation** | 75,419 | 76,974 | 2.06 | 76,954 | 2.04 | 76,873 | 1.93 | 76,665 | 1.65 | 76,665 | 1.65 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN Census 1991a.

TABLE D.3–11.—*County and City Revenues and Expenditures for Idaho National Engineering Laboratory Region-of-Influence, 1992*

| Revenues and Expenditures | Banncock County | Pocattelo[a] | Bingham County[a] | Blackfoot | Bonneville | Idaho Falls | Butte | Jefferson | Rigby |
|---|---|---|---|---|---|---|---|---|---|
| Property tax (percent) | 44 | 47 | 44 | 39 | 49 | 54 | 33 | 34 | 42 |
| Intergovernmental (percent) | 25 | 19 | 31 | 32 | 32 | 25 | 54 | 38 | 40 |
| Permits, fees, fines, and investment interest (percent) | 23 | 12 | 14 | 18 | 15 | 16 | 3 | 16 | 7 |
| Other (percent) | 8 | 22 | 11 | 11 | 4 | 5 | 10 | 12 | 12 |
| **Total Revenues (dollars)** | 17,270,189 | 17,176,656 | 11,045,505 | 3,741,621 | 18,302,511 | 23,625,020 | 1,524,987 | 5,016,650 | 848,282 |
| General Government (percent) | 39 | 15 | 28 | 14 | 40 | 9 | 35 | 29 | 23 |
| Public safety, health, and community service (percent) | 39 | 34 | 39 | 46 | 35 | 43 | 25 | 21 | 24 |
| Public works, parks, culture, and recreation (percent) | 21 | 27 | 25 | 24 | 25 | 40 | 37 | 39 | 32 |
| Debt service (percent) | 0 | 3 | 3 | 1 | 0 | 2 | 0 | 0 | 6 |
| Other (percent) | 0 | 21 | 5 | 15 | 0 | 5 | 4 | 11 | 16 |
| **Total Expenditures (dollars)** | 17,808,705 | 17,282,164 | 15,064,797 | 3,870,197 | 17,557,221 | 23,226,057 | 1,365,238 | 4,660,790 | 774,503 |
| **End-of-Year Fund Balance (dollars)** | 8,999,439 | 5,565,153 | 2,295,116 | 929,413 | 6,645,316 | 12,855,444 | 341,780 | 3,159,247 | 941,925 |

[a] Estimated from 1989 - 1991 financial audits and 1992 fiscal budgets.

Source: IN City 1992a; IN County 1992a.

**TABLE D.3–12.—*School District Revenues and Expenditures for Idaho National Engineering Laboratory Region-of-Influence, 1992***

| Revenues and Expenditures | Bannock County | Bingham County | | | Bonneville County | | Butte County | Jefferson County | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pocatello | Blackfoot | Shelley | Snake River | Bonneville | Idaho Falls | Arco | Jefferson | Ririe | West Jefferson |
| Property tax (percent) | 20 | 14 | 21 | 21 | 19 | 28 | 20 | 18 | 14 | 20 |
| Intergovernmental (percent) | 4 | 3 | 4 | 4 | 5 | 8 | 3 | 4 | 5 | 5 |
| Permits, fees, fines, and investment interest (percent) | 67 | 70 | 67 | 67 | 68 | 59 | 69 | 70 | 77 | 67 |
| Other (percent) | 9 | 13 | 8 | 8 | 7 | 6 | 7 | 8 | 4 | 8 |
| **Total Revenues (dollars)** | 44,626,005 | 15,004,512 | 8,105,837 | 8,194,101 | 24,411,504 | 39,495,369 | 2,874,222 | 12,246,830 | 2,711,816 | 2,980,423 |
| Total expenditures per pupil (dollars) | 3,276 | 3,387 | 3,793 | 3,206 | 4,360 | 4,257 | 3,598 | 3,3,15 | 3,827 | 3,811 |
| Instruction (percent) | 59 | 59 | 52 | 57 | 41 | 51 | 57 | 53 | 60 | 53 |
| Support services (percent) | 33 | 35 | 23 | 27 | 20 | 28 | 34 | 24 | 31 | 37 |
| Food and community services (percent) | 5 | 5 | 6 | 5 | 3 | 4 | 3 | 5 | 6 | 5 |
| Capital assets (percent) | 0 | 1 | 12 | 6 | 31 | 14 | 4 | 7 | 3 | 4 |
| Debt service (percent) | 2 | 0 | 7 | 5 | 5 | 3 | 2 | 11 | 0 | 4 |
| **Total Expenditures (dollars)** | 45,291,238 | 15,584,405 | 8,977,931 | 7,648,387 | 32,257,927 | 41,966,174 | 2,790,568 | 12,811,473 | 2,512,575 | 2,957,294 |
| **End-of-Year Fund Balance (dollars)** | 2,347,741 | 243,702 | 183,986 | 1,155,586 | 2,276,978 | 4,235,906 | 365,756 | 2,724,065 | 921,078 | 589,393 |

Source: IN City 1992a; IN County 1992a; IN School 1992a.

**TABLE D.3–13.—*Changes in County and City Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies for Idaho National Engineering Laboratory Region-of-Influence, 2005 (2003 for Phased APT)***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Bannock County | 17,300,653 | 17,379,360 | 0.45 | 17,372,554 | 0.42 | 17,452,507 | 0.88 | 17,330,972 | 0.18 | 17,222,234 | 0.07 |
| Pocatello | 17,738,488 | 17,806,758 | 0.38 | 17,800,707 | 0.35 | 17,871,809 | 0.75 | 17,764,039 | 0.14 | 17,678,011 | 0.06 |
| Bingham County | 11,404,006 | 11,523,729 | 1.05 | 11,513,062 | 0.96 | 11,637,966 | 2.05 | 11,448,547 | 0.39 | 11,378,285 | 0.16 |
| Blackfoot | 3,855,503 | 3,913,851 | 1.51 | 3,909,816 | 1.41 | 3,956,944 | 2.63 | 3,883,139 | 0.72 | 3,852,273 | 0.32 |
| Bonneville County | 17,652,244 | 18,455,698 | 4.55 | 18,380,022 | 4.12 | 19,269,859 | 9.16 | 17,928,868 | 1.57 | 17,678,877 | 0.59 |
| Idaho Falls | 23,088,012 | 24,337,362 | 5.41 | 24,219,381 | 4.90 | 25,606,670 | 10.91 | 23,516,596 | 1.86 | 23,115,440 | 0.70 |
| Butte County | 1,488,215 | 1,544,878 | 3.81 | 1,539,617 | 3.45 | 1,604,375 | 7.81 | 1,506,833 | 1.25 | 1,486,575 | 0.48 |
| Jefferson County | 4,741,700 | 4,814,833 | 1.54 | 4,808,184 | 1.40 | 4,885,596 | 3.03 | 4,768,378 | 0.56 | 4,734,555 | 0.22 |
| Rigby | 822,765 | 839,930 | 2.09 | 838,256 | 1.88 | 857,735 | 4.25 | 828,463 | 0.69 | 820,204 | 0.26 |
| **Total ROI Revenues** | 98,091,586 | 100,616,399 | 2.57 | 100,381,600 | 2.33 | 103,143,459 | 5.15 | 98,975,835 | 0.90 | 97,966,454 | 0.35 |
| **Expenditures** | | | | | | | | | | | |
| Bannock County | 17,686,173 | 17,710,968 | 0.14 | 17,708,570 | 0.13 | 17,736,778 | 0.29 | 17,694,434 | 0.05 | 17,659,165 | 0.02 |
| Pocatello | 17,486,430 | 17,564,856 | 0.45 | 17,557,271 | 0.41 | 17,646,493 | 0.92 | 17,512,561 | 0.15 | 17,401,311 | 0.06 |
| Bingham County | 11,372,761 | 11,489,695 | 1.03 | 11,478,360 | 0.93 | 11,611,187 | 2.10 | 11,411,592 | 0.34 | 11,339,183 | 0.13 |
| Blackfoot | 3,793,678 | 3,840,687 | 1.24 | 3,836,131 | 1.12 | 3,889,529 | 2.53 | 3,809,289 | 0.41 | 3,776,641 | 0.15 |
| Bonneville County | 17,721,518 | 18,132,553 | 2.32 | 18,092,887 | 2.10 | 18,559,362 | 4.73 | 17,858,187 | 0.77 | 17,734,624 | 0.28 |
| Idaho Falls | 23,755,117 | 24,241,662 | 2.05 | 24,194,709 | 1.85 | 24,746,877 | 4.17 | 23,916,893 | 0.68 | 23,771,322 | 0.25 |
| Butte County | 1,443,508 | 1,485,278 | 2.89 | 1,481,400 | 2.62 | 1,529,136 | 5.93 | 1,457,233 | 0.95 | 1,442,300 | 0.36 |
| Jefferson County | 4,797,349 | 4,915,410 | 2.46 | 4,903,898 | 2.22 | 5,037,880 | 5.01 | 4,836,539 | 0.82 | 4,782,841 | 0.30 |
| Rigby | 842,701 | 847,953 | 0.62 | 847,441 | 0.56 | 853,401 | 1.27 | 844,444 | 0.21 | 844,088 | 0.08 |
| **Total ROI Expenditures** | 98,899,235 | 100,229,062 | 1.34 | 100,100,667 | 1.21 | 101,610,643 | 2.74 | 99,341,172 | 0.45 | 98,751,475 | 0.17 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN Census 1991a; IN City 1992a; IN County 1992a; IN DOC 1991a.

TABLE D.3–14.—*Changes to County and City Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies for Idaho National Engineering Laboratory Region-of-Influence, 2010*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Bannock County | 17,495,800 | 17,516,300 | 0.12 | 17,515,695 | 0.11 | 17,510,984 | 0.09 | 17,507,324 | 0.07 | 17,507,324 | 0.07 |
| Pocatello | 17,917,798 | 17,935,160 | 0.10 | 17,934,636 | 0.09 | 17,930,569 | 0.07 | 17,927,404 | 0.05 | 17,927,404 | 0.05 |
| Bingham County | 11,515,415 | 11,545,737 | 0.26 | 11,544,819 | 0.26 | 11,537,628 | 0.19 | 11,532,254 | 0.15 | 11,532,254 | 0.15 |
| Blackfoot | 3,894,581 | 3,912,816 | 0.47 | 3,912,355 | 0.46 | 3,908,703 | 0.36 | 3,905,939 | 0.29 | 3,905,939 | 0.29 |
| Bonneville County | 17,836,074 | 18,026,992 | 1.07 | 18,021,095 | 1.04 | 17,973,552 | 0.77 | 17,936,995 | 0.57 | 17,936,995 | 0.57 |
| Idaho Falls | 23,374,411 | 23,670,313 | 1.27 | 23,661,149 | 1.23 | 23,587,276 | 0.91 | 23,530,467 | 0.67 | 23,530,467 | 0.67 |
| Butte County | 1,510,543 | 1,523,495 | 0.86 | 1,523,090 | 0.83 | 1,519,852 | 0.62 | 1,517,424 | 0.46 | 1,517,424 | 0.46 |
| Jefferson County | 4,784,517 | 4,802,793 | 0.38 | 4,802,319 | 0.37 | 4,797,863 | 0.28 | 4,794,468 | 0.21 | 4,794,468 | 0.21 |
| Rigby | 833,450 | 837,403 | 0.47 | 837,296 | 0.46 | 836,263 | 0.34 | 835,480 | 0.24 | 835,480 | 0.24 |
| **Total ROI Revenues** | 99,162,589 | 99,771,008 | 0.61 | 99,752,454 | 0.59 | 99,602,690 | 0.44 | 99,487,755 | 0.33 | 99,487,755 | 0.33 |
| **Expenditures** | | | | | | | | | | | |
| Bannock County | 17,762,280 | 17,768,014 | 0.03 | 17,767,825 | 0.03 | 17,766,374 | 0.02 | 17,765,238 | 0.02 | 17,765,238 | 0.02 |
| Pocatello | 17,727,414 | 17,745,551 | 0.10 | 17,744,952 | 0.10 | 17,740,361 | 0.07 | 17,736,768 | 0.05 | 17,736,768 | 0.05 |
| Bingham County | 11,494,117 | 11,521,009 | 0.23 | 11,520,123 | 0.23 | 11,513,216 | 0.17 | 11,508,080 | 0.12 | 11,508,080 | 0.12 |
| Blackfoot | 3,841,961 | 3,852,772 | 0.28 | 3,852,416 | 0.27 | 3,849,639 | 0.20 | 3,847,574 | 0.15 | 3,847,574 | 0.15 |
| Bonneville County | 17,815,897 | 17,910,549 | 0.53 | 17,907,548 | 0.51 | 17,883,397 | 0.38 | 17,864,809 | 0.27 | 17,864,809 | 0.27 |
| Idaho Falls | 23,864,119 | 23,976,158 | 0.47 | 23,972,606 | 0.45 | 23,944,019 | 0.33 | 23,922,015 | 0.24 | 23,922,015 | 0.24 |
| Butte County | 1,459,933 | 1,469,481 | 0.65 | 1,469,182 | 0.63 | 1,466,796 | 0.47 | 1,465,005 | 0.35 | 1,465,005 | 0.35 |
| Jefferson County | 4,870,096 | 4,897,285 | 0.56 | 4,896,550 | 0.54 | 4,889,446 | 0.40 | 4,884,058 | 0.29 | 4,884,058 | 0.29 |
| Rigby | 846,664 | 847,874 | 0.14 | 847,841 | 0.14 | 847,525 | 0.10 | 847,285 | 0.07 | 847,285 | 0.07 |
| **Total ROI Expenditures** | 99,682,481 | 99,988,691 | 0.31 | 99,979,043 | 0.30 | 99,900,773 | 0.22 | 99,840,833 | 0.16 | 99,840,833 | 0.16 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN Census 1991a; IN City 1992a; IN County 1992a; IN DOC 1991a.

TABLE D.3–15.—*Changes to School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies for Idaho National Engineering Laboratory Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Arco | 3,005,283 | 3,053,956 | 1.62 | 3,049,880 | 1.48 | 3,099,741 | 3.14 | 3,023,762 | 0.61 | 3,003,194 | 0.25 |
| Blackfoot | 15,987,856 | 16,255,445 | 1.67 | 16,229,507 | 1.51 | 16,533,469 | 3.41 | 16,076,716 | 0.56 | 15,910,941 | 0.21 |
| Bonneville | 28,642,438 | 30,626,604 | 6.93 | 30,444,417 | 6.29 | 32,586,402 | 13.77 | 29,349,440 | 2.47 | 28,718,593 | 0.96 |
| Idaho Falls | 41,388,574 | 44,683,027 | 7.96 | 44,388,652 | 7.25 | 47,849,123 | 15.61 | 42,603,797 | 2.94 | 41,501,628 | 1.16 |
| Jefferson | 12,764,278 | 13,140,238 | 2.95 | 13,105,290 | 2.67 | 13,512,109 | 5.86 | 12,897,639 | 1.04 | 12,715,411 | 0.40 |
| Pocatello | 47,015,081 | 47,280,774 | 0.57 | 47,255,078 | 0.51 | 47,557,342 | 1.15 | 47,103,607 | 0.19 | 46,725,675 | 0.07 |
| Ririe | 2,546,424 | 2,570,450 | 0.94 | 2,568,615 | 0.87 | 2,589,999 | 1.71 | 2,556,938 | 0.41 | 2,538,124 | 0.18 |
| Shelley | 9,604,500 | 9,753,568 | 1.55 | 9,739,767 | 1.41 | 9,901,482 | 3.09 | 9,657,279 | 0.55 | 9,591,409 | 0.21 |
| Snake River | 8,385,061 | 8,440,562 | 0.66 | 8,435,908 | 0.61 | 8,490,432 | 1.26 | 8,407,159 | 0.26 | 8,365,119 | 0.11 |
| West Jefferson | 3,110,676 | 3,203,007 | 2.97 | 3,194,490 | 2.69 | 3,293,636 | 5.88 | 3,143,757 | 1.06 | 3,098,573 | 0.41 |
| **Total ROI Revenues** | 172,450,171 | 179,007,631 | 3.80 | 178,411,604 | 3.46 | 185,413,734 | 7.52 | 174,820,095 | 1.37 | 172,168,666 | 0.54 |
| **Expenditures** | | | | | | | | | | | |
| Arco | 2,942,204 | 3,066,443 | 4.22 | 3,054,906 | 3.83 | 3,196,893 | 8.66 | 2,983,025 | 1.39 | 2,937,220 | 0.53 |
| Blackfoot | 15,344,053 | 15,518,829 | 1.14 | 15,501,888 | 1.03 | 15,700,420 | 2.32 | 15,402,093 | 0.38 | 15,280,889 | 0.14 |
| Bonneville | 28,377,490 | 29,968,505 | 5.61 | 29,814,969 | 5.07 | 31,620,573 | 11.43 | 28,906,502 | 1.86 | 28,333,414 | 0.69 |
| Idaho Falls | 40,023,608 | 42,705,819 | 6.70 | 42,446,981 | 6.05 | 45,490,955 | 13.66 | 40,915,442 | 2.23 | 40,048,407 | 0.83 |
| Jefferson | 12,385,854 | 12,690,706 | 2.46 | 12,660,980 | 2.22 | 13,006,944 | 5.01 | 12,487,050 | 0.82 | 12,334,478 | 0.30 |
| Pocatello | 46,998,053 | 47,245,810 | 0.53 | 47,221,849 | 0.48 | 47,503,709 | 1.08 | 47,080,603 | 0.18 | 46,723,286 | 0.07 |
| Ririe | 2,614,477 | 2,685,319 | 2.71 | 2,678,411 | 2.45 | 2,758,806 | 5.52 | 2,637,993 | 0.90 | 2,606,449 | 0.33 |
| Shelley | 10,262,219 | 10,389,417 | 1.24 | 10,377,087 | 1.12 | 10,521,574 | 2.53 | 10,304,458 | 0.41 | 10,224,064 | 0.15 |
| Snake River | 8,088,610 | 8,207,597 | 1.47 | 8,196,064 | 1.33 | 8,331,224 | 3.00 | 8,128,123 | 0.49 | 8,054,177 | 0.18 |
| West Jefferson | 3,046,831 | 3,128,895 | 2.69 | 3,120,893 | 2.43 | 3,214,022 | 5.49 | 3,074,072 | 0.89 | 3,036,629 | 0.33 |
| **Total ROI Expenditures** | 170,083,400 | 175,607,340 | 3.25 | 175,074,027 | 2.93 | 181,345,119 | 6.62 | 171,919,362 | 1.08 | 169,579,011 | 0.40 |

Source: Census 1973a;Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN Census 1991a; IN DOC 1991a; IN School 1992a.

**TABLE D.3–16.—*Changes to School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies for Idaho National Engineering Laboratory Region-of-Influence, 2010***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Arco | 3,029,757 | 3,042,880 | 0.43 | 3,042,510 | 0.42 | 3,039,545 | 0.32 | 3,037,320 | 0.25 | 3,037,320 | 0.25 |
| Blackfoot | 16,265,237 | 16,326,775 | 0.38 | 16,324,749 | 0.37 | 16,308,943 | 0.27 | 16,297,189 | 0.20 | 16,297,189 | 0.20 |
| Bonneville | 29,145,644 | 29,640,791 | 1.70 | 29,625,931 | 1.65 | 29,506,117 | 1.24 | 29,414,143 | 0.92 | 29,414,143 | 0.92 |
| Idaho Falls | 42,326,502 | 43,182,076 | 2.02 | 43,157,072 | 1.96 | 42,955,310 | 1.49 | 42,800,639 | 1.12 | 42,800,639 | 1.12 |
| Jefferson | 13,017,612 | 13,111,104 | 0.72 | 13,108,658 | 0.70 | 13,085,503 | 0.52 | 13,067,951 | 0.39 | 13,067,951 | 0.39 |
| Pocatello | 47,830,642 | 47,892,085 | 0.13 | 47,890,056 | 0.12 | 47,874,503 | 0.09 | 47,862,332 | 0.07 | 47,862,332 | 0.07 |
| Ririe | 2,566,733 | 2,574,315 | 0.30 | 2,574,135 | 0.29 | 2,572,530 | 0.23 | 2,571,317 | 0.18 | 2,571,317 | 0.18 |
| Shelley | 9,786,330 | 9,823,262 | 0.38 | 9,822,111 | 0.37 | 9,813,086 | 0.27 | 9,806,367 | 0.20 | 9,806,367 | 0.20 |
| Snake River | 8,459,527 | 8,475,257 | 0.19 | 8,474,812 | 0.18 | 8,471,288 | 0.14 | 8,468,657 | 0.11 | 8,468,657 | 0.11 |
| West Jefferson | 3,173,725 | 3,196,951 | 0.73 | 3,196,347 | 0.71 | 3,190,639 | 0.53 | 3,186,314 | 0.40 | 3,186,314 | 0.40 |
| **Total ROI Revenues** | 175,601,709 | 177,265,496 | 0.95 | 177,216,380 | 0.92 | 176,817,465 | 0.69 | 176,512,229 | 0.52 | 176,512,229 | 0.52 |
| **Expenditures** | | | | | | | | | | | |
| Arco | 2,990,995 | 3,019,393 | 0.95 | 3,018,505 | 0.92 | 3,011,406 | 0.68 | 3,006,082 | 0.50 | 3,006,082 | 0.50 |
| Blackfoot | 15,523,365 | 15,563,559 | 0.26 | 15,562,235 | 0.25 | 15,551,912 | 0.18 | 15,544,235 | 0.13 | 15,544,235 | 0.13 |
| Bonneville | 28,724,762 | 29,091,134 | 1.28 | 29,079,519 | 1.24 | 28,986,038 | 0.91 | 28,914,086 | 0.66 | 28,914,086 | 0.66 |
| Idaho Falls | 40,629,058 | 41,246,704 | 1.52 | 41,227,124 | 1.47 | 41,069,529 | 1.08 | 40,948,229 | 0.79 | 40,948,229 | 0.79 |
| Jefferson | 12,572,160 | 12,642,365 | 0.56 | 12,640,468 | 0.54 | 12,622,126 | 0.40 | 12,608,212 | 0.29 | 12,608,212 | 0.29 |
| Pocatello | 47,757,386 | 47,814,681 | 0.12 | 47,812,790 | 0.12 | 47,798,287 | 0.09 | 47,786,937 | 0.06 | 47,786,937 | 0.06 |
| Ririe | 2,658,277 | 2,674,591 | 0.61 | 2,674,150 | 0.60 | 2,669,888 | 0.44 | 2,666,655 | 0.32 | 2,666,655 | 0.32 |
| Shelley | 10,384,108 | 10,413,360 | 0.28 | 10,412,397 | 0.27 | 10,404,884 | 0.20 | 10,399,297 | 0.15 | 10,399,297 | 0.15 |
| Snake River | 8,210,458 | 8,237,821 | 0.33 | 8,236,920 | 0.32 | 8,229,892 | 0.24 | 8,224,666 | 0.17 | 8,224,666 | 0.17 |
| West Jefferson | 3,097,371 | 3,116,270 | 0.61 | 3,115,759 | 0.59 | 3,110,822 | 0.43 | 3,107,076 | 0.31 | 3,107,076 | 0.31 |
| **Total ROI Expenditures** | 172,547,942 | 173,819,879 | 0.74 | 173,779,868 | 0.71 | 173,454,783 | 0.53 | 173,205,473 | 0.38 | 173,205,473 | 0.38 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; IN Census 1991a; IN DOC 1991a; IN School 1992a.

TABLE D.3–17.—*Changes to County and City Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Bannock County | 17,300,653 | 17,400,105 | 0.57 | 17,393,310 | 0.54 | 17,472,946 | 1.00 | 17,340,167 | 0.23 | 17,230,940 | 0.12 |
| Pocatello | 17,738,488 | 17,825,207 | 0.49 | 17,819,164 | 0.45 | 17,889,975 | 0.85 | 17,771,908 | 0.19 | 17,685,437 | 0.10 |
| Bingham County | 11,404,006 | 11,556,033 | 1.33 | 11,545,386 | 1.24 | 11,669,813 | 2.33 | 11,462,441 | 0.51 | 11,391,567 | 0.28 |
| Blackfoot | 3,855,503 | 3,926,034 | 1.83 | 3,922,032 | 1.73 | 3,969,011 | 2.94 | 3,890,724 | 0.91 | 3,859,700 | 0.51 |
| Bonneville County | 17,652,244 | 18,685,917 | 5.86 | 18,610,115 | 5.43 | 19,497,079 | 10.45 | 18,018,981 | 2.08 | 17,763,775 | 1.08 |
| Idaho Falls | 23,088,012 | 24,696,279 | 6.97 | 24,578,101 | 6.45 | 25,960,901 | 12.44 | 23,656,509 | 2.46 | 23,247,203 | 1.28 |
| Butte County | 1,488,215 | 1,561,877 | 4.95 | 1,556,211 | 4.57 | 1,620,969 | 8.92 | 1,513,309 | 1.69 | 1,492,240 | 0.86 |
| Jefferson County | 4,741,700 | 4,834,781 | 1.96 | 4,828,263 | 1.83 | 4,905,432 | 3.45 | 4,776,750 | 0.74 | 4,742,529 | 0.39 |
| Rigby | 822,765 | 844,951 | 2.70 | 843,313 | 2.50 | 862,721 | 4.86 | 830,350 | 0.92 | 821,984 | 0.47 |
| **Total ROI Revenues** | 98,091,586 | 101,331,184 | 3.30 | 101,095,895 | 3.06 | 103,848,846 | 5.87 | 99,261,138 | 1.19 | 98,235,375 | 0.62 |
| **Expenditures** | | | | | | | | | | | |
| Bannock County | 17,686,173 | 17,718,288 | 0.18 | 17,715,890 | 0.17 | 17,743,972 | 0.33 | 17,697,148 | 0.06 | 17,661,689 | 0.03 |
| Pocatello | 17,486,430 | 17,588,010 | 0.58 | 17,580,425 | 0.54 | 17,669,248 | 1.05 | 17,521,143 | 0.20 | 17,409,295 | 0.10 |
| Bingham County | 11,372,761 | 11,524,053 | 1.33 | 11,512,718 | 1.23 | 11,645,014 | 2.39 | 11,424,521 | 0.46 | 11,351,403 | 0.24 |
| Blackfoot | 3,793,678 | 3,854,500 | 1.60 | 3,849,943 | 1.48 | 3,903,128 | 2.89 | 3,814,486 | 0.55 | 3,781,553 | 0.28 |
| Bonneville County | 17,721,518 | 18,253,233 | 3.00 | 18,213,495 | 2.78 | 18,678,432 | 5.40 | 17,903,634 | 1.03 | 17,777,275 | 0.53 |
| Idaho Falls | 23,755,117 | 24,384,511 | 2.65 | 24,337,472 | 2.45 | 24,887,820 | 4.77 | 23,970,689 | 0.91 | 23,821,809 | 0.46 |
| Butte County | 1,443,508 | 1,497,809 | 3.76 | 1,493,632 | 3.47 | 1,541,369 | 6.78 | 1,462,006 | 1.28 | 1,446,476 | 0.65 |
| Jefferson County | 4,797,349 | 4,949,947 | 3.18 | 4,938,679 | 2.95 | 5,072,172 | 5.73 | 4,849,521 | 1.09 | 4,795,087 | 0.56 |
| Rigby | 842,701 | 849,490 | 0.81 | 848,988 | 0.75 | 854,927 | 1.45 | 845,022 | 0.28 | 844,633 | 0.14 |
| **Total ROI Expenditures** | 98,899,235 | 100,619,840 | 1.74 | 100,491,243 | 1.61 | 101,996,081 | 3.13 | 99,488,171 | 0.60 | 98,889,220 | 0.31 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN Census 1991a; IN City 1992a; IN County 1992a; IN DOC 1991a.

**TABLE D.3–18.—*Changes to County and City Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2010***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Bannock County | 17,495,800 | 17,542,876 | 0.27 | 17,542,271 | 0.27 | 17,539,842 | 0.25 | 17,533,890 | 0.22 | 17,533,890 | 0.22 |
| Pocatello | 17,917,798 | 17,958,114 | 0.23 | 17,957,591 | 0.22 | 17,955,488 | 0.21 | 17,950,351 | 0.18 | 17,950,351 | 0.18 |
| Bingham County | 11,515,415 | 11,585,975 | 0.61 | 11,585,210 | 0.61 | 11,581,538 | 0.57 | 11,572,492 | 0.50 | 11,572,492 | 0.50 |
| Blackfoot | 3,894,581 | 3,933,305 | 0.99 | 3,932,882 | 0.98 | 3,931,037 | 0.94 | 3,926,429 | 0.82 | 3,926,429 | 0.82 |
| Bonneville County | 17,836,074 | 18,294,419 | 2.57 | 18,288,523 | 2.54 | 18,265,040 | 2.41 | 18,204,422 | 2.07 | 18,204,422 | 2.07 |
| Idaho Falls | 23,374,411 | 24,085,863 | 3.04 | 24,076,699 | 3.00 | 24,040,212 | 2.85 | 23,946,017 | 2.45 | 23,946,017 | 2.45 |
| Butte County | 1,510,543 | 1,542,518 | 2.12 | 1,542,113 | 2.09 | 1,540,494 | 1.98 | 1,536,042 | 1.69 | 1,536,042 | 1.69 |
| Jefferson County | 4,784,517 | 4,827,315 | 0.89 | 4,826,841 | 0.88 | 4,824,679 | 0.84 | 4,819,122 | 0.72 | 4,819,122 | 0.72 |
| Rigby | 833,450 | 843,065 | 1.15 | 842,958 | 1.14 | 842,460 | 1.08 | 841,178 | 0.93 | 841,178 | 0.93 |
| **Total ROI Revenues** | 99,162,589 | 100,613,451 | 1.46 | 100,595,087 | 1.44 | 100,520,789 | 1.37 | 100,329,942 | 1.18 | 100,329,942 | 1.18 |
| **Expenditures** | | | | | | | | | | | |
| Bannock County | 17,762,280 | 17,776,218 | 0.08 | 17,776,029 | 0.08 | 17,775,271 | 0.07 | 17,773,441 | 0.06 | 17,773,441 | 0.06 |
| Pocatello | 17,727,414 | 17,771,499 | 0.25 | 17,770,900 | 0.25 | 17,768,505 | 0.23 | 17,762,717 | 0.20 | 17,762,717 | 0.20 |
| Bingham County | 11,494,117 | 11,559,617 | 0.57 | 11,558,909 | 0.56 | 11,555,367 | 0.53 | 11,546,688 | 0.46 | 11,546,688 | 0.46 |
| Blackfoot | 3,841,961 | 3,868,293 | 0.69 | 3,868,008 | 0.68 | 3,866,584 | 0.64 | 3,863,095 | 0.55 | 3,863,095 | 0.55 |
| Bonneville County | 17,815,897 | 18,046,451 | 1.29 | 18,043,451 | 1.28 | 18,031,522 | 1.21 | 18,000,711 | 1.04 | 18,000,711 | 1.04 |
| Idaho Falls | 23,864,119 | 24,137,026 | 1.14 | 24,133,474 | 1.13 | 24,119,354 | 1.07 | 24,082,884 | 0.92 | 24,082,884 | 0.92 |
| Butte County | 1,459,933 | 1,483,503 | 1.61 | 1,483,205 | 1.59 | 1,482,012 | 1.51 | 1,478,730 | 1.29 | 1,478,730 | 1.29 |
| Jefferson County | 4,870,096 | 4,936,230 | 1.36 | 4,935,495 | 1.34 | 4,932,066 | 1.27 | 4,923,248 | 1.09 | 4,923,248 | 1.09 |
| Rigby | 846,664 | 849,606 | 0.35 | 849,574 | 0.34 | 849,421 | 0.33 | 849,029 | 0.28 | 849,029 | 0.28 |
| **Total ROI Expenditures** | 99,682,481 | 100,428,444 | 0.75 | 100,419,044 | 0.74 | 100,380,101 | 0.70 | 100,280,543 | 0.60 | 100,280,543 | 0.60 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN Census 1991a; IN City 1992a; IN County 1992a; IN DOC 1991a.

TABLE D.3–19.— *Changes to School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Arco | 3,005,283 | 3,067,029 | 2.05 | 3,062,678 | 1.91 | 3,112,542 | 3.57 | 3,029,621 | 0.81 | 3,008,495 | 0.43 |
| Blackfoot | 15,987,856 | 16,334,070 | 2.17 | 16,308,132 | 2.00 | 16,610,877 | 3.90 | 16,106,302 | 0.74 | 15,938,903 | 0.38 |
| Bonneville | 28,642,438 | 31,180,853 | 8.86 | 30,998,372 | 8.23 | 33,133,702 | 15.68 | 29,575,244 | 3.26 | 28,932,110 | 1.71 |
| Idaho Falls | 41,388,574 | 45,578,535 | 10.12 | 45,283,723 | 9.41 | 48,733,811 | 17.75 | 42,984,330 | 3.86 | 41,862,815 | 2.04 |
| Jefferson | 12,764,278 | 13,245,139 | 3.77 | 13,210,905 | 3.50 | 13,616,314 | 6.68 | 12,940,160 | 1.38 | 12,755,792 | 0.72 |
| Pocatello | 47,015,081 | 47,359,214 | 0.73 | 47,333,518 | 0.68 | 47,634,430 | 1.32 | 47,132,684 | 0.25 | 46,752,722 | 0.13 |
| Ririe | 2,546,424 | 2,575,973 | 1.16 | 2,574,168 | 1.09 | 2,595,497 | 1.93 | 2,559,930 | 0.53 | 2,541,027 | 0.29 |
| Shelley | 9,604,500 | 9,795,406 | 1.99 | 9,781,606 | 1.84 | 9,942,708 | 3.52 | 9,674,205 | 0.73 | 9,607,507 | 0.38 |
| Snake River | 8,385,061 | 8,454,674 | 0.83 | 8,450,021 | 0.77 | 8,504,365 | 1.42 | 8,413,792 | 0.34 | 8,371,502 | 0.18 |
| West Jefferson | 3,110,676 | 3,228,574 | 3.79 | 3,220,230 | 3.52 | 3,319,035 | 6.70 | 3,154,245 | 1.40 | 3,108,543 | 0.74 |
| **Total ROI Revenues** | 172,450,171 | 180,819,466 | 4.85 | 180,223,352 | 4.51 | 187,203,281 | 8.55 | 175,570,513 | 1.81 | 172,879,419 | 0.95 |
| **Expenditures** | | | | | | | | | | | |
| Arco | 2,942,204 | 3,103,714 | 5.49 | 3,091,290 | 5.07 | 3,233,277 | 9.89 | 2,997,224 | 1.87 | 2,949,642 | 0.95 |
| Blackfoot | 15,344,053 | 15,570,183 | 1.47 | 15,553,242 | 1.36 | 15,750,979 | 2.65 | 15,421,416 | 0.50 | 15,299,152 | 0.26 |
| Bonneville | 28,377,490 | 30,435,628 | 7.25 | 30,281,809 | 6.71 | 32,081,464 | 13.05 | 29,082,417 | 2.48 | 28,498,508 | 1.28 |
| Idaho Falls | 40,023,608 | 43,493,317 | 8.67 | 43,234,001 | 8.02 | 46,267,947 | 15.60 | 41,212,008 | 2.97 | 40,326,730 | 1.53 |
| Jefferson | 12,385,854 | 12,779,885 | 3.18 | 12,750,792 | 2.95 | 13,095,490 | 5.73 | 12,520,571 | 1.09 | 12,366,097 | 0.56 |
| Pocatello | 46,998,053 | 47,318,955 | 0.68 | 47,294,994 | 0.63 | 47,575,593 | 1.23 | 47,107,717 | 0.23 | 46,748,508 | 0.12 |
| Ririe | 2,614,477 | 2,706,042 | 3.50 | 2,699,282 | 3.24 | 2,779,383 | 6.31 | 2,645,783 | 1.20 | 2,613,797 | 0.62 |
| Shelley | 10,262,219 | 10,426,790 | 1.60 | 10,414,461 | 1.48 | 10,558,370 | 2.89 | 10,318,522 | 0.55 | 10,237,356 | 0.28 |
| Snake River | 8,088,610 | 8,242,559 | 1.90 | 8,231,025 | 1.76 | 8,365,644 | 3.42 | 8,141,279 | 0.65 | 8,066,611 | 0.34 |
| West Jefferson | 3,046,831 | 3,152,901 | 3.48 | 3,145,069 | 3.22 | 3,237,858 | 6.27 | 3,083,096 | 1.19 | 3,045,140 | 0.61 |
| **Total ROI Expenditures** | 170,083,400 | 177,229,974 | 4.20 | 176,695,963 | 3.89 | 182,946,005 | 7.56 | 172,530,032 | 1.44 | 170,151,540 | 0.74 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN Census 1991a; IN DOC 1991a; IN School 192a.

**TABLE D.3–20.—*Changes in School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling for Idaho National Engineering Laboratory Region-of-Influence, 2010***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Arco | 3,029,757 | 3,060,074 | 1.00 | 3,059,704 | 0.99 | 3,058,229 | 0.94 | 3,054,236 | 0.81 | 3,054,236 | 0.81 |
| Blackfoot | 16,265,237 | 16,415,126 | 0.92 | 16,413,505 | 0.91 | 16,405,400 | 0.86 | 16,385,541 | 0.74 | 16,385,541 | 0.74 |
| Bonneville | 29,145,644 | 30,314,284 | 4.01 | 30,299,423 | 3.96 | 30,240,294 | 3.76 | 30,087,634 | 3.23 | 30,087,634 | 3.23 |
| Idaho Falls | 42,326,502 | 44,315,592 | 4.70 | 44,290,589 | 4.64 | 44,191,061 | 4.41 | 43,934,152 | 3.80 | 43,934,152 | 3.80 |
| Jefferson | 13,017,612 | 13,238,305 | 1.70 | 13,235,859 | 1.68 | 13,224,661 | 1.59 | 13,195,861 | 1.37 | 13,195,861 | 1.37 |
| Pocatello | 47,830,642 | 47,979,992 | 0.31 | 47,977,963 | 0.31 | 47,969,849 | 0.29 | 47,950,239 | 0.25 | 47,950,239 | 0.25 |
| Ririe | 2,566,733 | 2,583,185 | 0.64 | 2,583,004 | 0.63 | 2,582,223 | 0.60 | 2,580,215 | 0.53 | 2,580,215 | 0.53 |
| Shelley | 9,786,330 | 9,873,695 | 0.89 | 9,872,750 | 0.88 | 9,868,144 | 0.84 | 9,856,799 | 0.72 | 9,856,799 | 0.72 |
| Snake River | 8,459,527 | 8,494,941 | 0.42 | 8,494,558 | 0.41 | 8,492,775 | 0.39 | 8,488,341 | 0.34 | 8,488,341 | 0.34 |
| West Jefferson | 3,173,725 | 3,228,312 | 1.72 | 3,227,708 | 1.70 | 3,224,947 | 1.61 | 3,217,846 | 1.39 | 3,217,846 | 1.39 |
| **Total ROI Revenues** | 175,601,709 | 179,503,504 | 2.22 | 179,455,062 | 2.19 | 179,257,582 | 2.08 | 178,750,864 | 1.79 | 178,750,864 | 1.79 |
| **Expenditures** | | | | | | | | | | | |
| Arco | 2,990,995 | 3,061,101 | 2.34 | 3,060,214 | 2.31 | 3,056,664 | 2.20 | 3,046,903 | 1.87 | 3,046,903 | 1.87 |
| Blackfoot | 15,523,365 | 15,621,265 | 0.63 | 15,620,207 | 0.62 | 15,614,912 | 0.59 | 15,601,942 | 0.51 | 15,601,942 | 0.51 |
| Bonneville | 28,724,762 | 29,617,178 | 3.11 | 29,605,564 | 3.07 | 29,559,390 | 2.91 | 29,440,130 | 2.49 | 29,440,130 | 2.49 |
| Idaho Falls | 40,629,058 | 42,133,535 | 3.70 | 42,113,955 | 3.65 | 42,036,113 | 3.46 | 41,835,060 | 2.97 | 41,835,060 | 2.97 |
| Jefferson | 12,572,160 | 12,742,929 | 1.36 | 12,741,031 | 1.34 | 12,732,177 | 1.27 | 12,709,408 | 1.09 | 12,709,408 | 1.09 |
| Pocatello | 47,757,386 | 47,896,654 | 0.29 | 47,894,762 | 0.29 | 47,887,196 | 0.27 | 47,868,909 | 0.23 | 47,868,909 | 0.23 |
| Ririe | 2,658,277 | 2,697,960 | 1.49 | 2,697,519 | 1.48 | 2,695,462 | 1.40 | 2,690,171 | 1.20 | 2,690,171 | 1.20 |
| Shelley | 10,384,108 | 10,455,358 | 0.69 | 10,454,587 | 0.68 | 10,450,734 | 0.64 | 10,441,294 | 0.55 | 10,441,294 | 0.55 |
| Snake River | 8,210,458 | 8,277,108 | 0.81 | 8,276,387 | 0.80 | 8,272,783 | 0.76 | 8,263,952 | 0.65 | 8,263,952 | 0.65 |
| West Jefferson | 3,097,371 | 3,143,340 | 1.48 | 3,142,830 | 1.47 | 3,140,446 | 1.39 | 3,134,317 | 1.19 | 3,134,317 | 1.19 |
| **Total ROI Expenditures** | 172,547,942 | 175,646,429 | 1.80 | 175,607,056 | 1.77 | 175,445,876 | 1.68 | 175,032,085 | 1.44 | 175,032,085 | 1.44 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; IN Census 1991a; IN DOC 1991a; IN School 1992a.

**TABLE D.3–21.—*Distribution of Employees by Place of Residence for Nevada Test Site, 1991***

| County/City | Number of Employees | Total Site Employment (percent) |
|---|---|---|
| Clark County | 6,270 | 81.7 |
| Henderson | 357 | 4.7 |
| Las Vegas | 5,352 | 69.7 |
| North Las Vegas | 505 | 6.6 |
| Nye County | 1,173 | 15.3 |
| **Total ROI County** | 7,443 | 97.0 |

Source: NTS 1991a:1.

**TABLE D.3–22.—*Employment and Local Economy Statistics for Nevada Test Site Economic Study Area, 1970-2020***

| Economic Study Area | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Civilian labor force | 125,772 | 250,392 | 402,960 | 511,330 | 542,466 | 553,345 |
| Total employment | 118,081 | 233,281 | 382,980 | 485,977 | 515,568 | 525,909 |
| Unemployment rate (percent) | 6.1 | 6.8 | 5.0 | 5.0 | 5.0 | 5.0 |
| Personal income (thousand dollars) | 1,433,059 | 5,431,787 | 14,753,586 | 22,346,743 | 24,809,815 | 28,415,457 |
| Per capita income (dollars per person) | 4,825 | 11,001 | 18,883 | 22,778 | 23,638 | 25,062 |

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; NT ESD 1991a.

**TABLE D.3–23.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Nevada Test Site Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 485,977 | 494,261 | 1.70 | 493,868 | 1.62 | 498,474 | 2.57 | 490,797 | 0.99 | 477,067 | 0.52 |
| Unemployment rate (percent) | 5.0 | 3.9 | NA | 3.9 | NA | 3.9 | NA | 4.2 | NA | 4.5 | NA |
| Per capita income (dollars per person) | 22,778 | 23,013 | 1.03 | 23,017 | 1.05 | 22,975 | 0.86 | 22,948 | 0.75 | 22,545 | 0.45 |
| **Operation** | | | | | | | | | | | |
| Total employment | 515,568 | 518,362 | 0.54 | 518,302 | 0.53 | 518,061 | 0.48 | 517,442 | 0.36 | 517,442 | 0.36 |
| Unemployment rate (percent) | 5.0 | 4.7 | NA | 4.6 | NA | 4.6 | NA | 4.7 | N/A | 4.7 | N/A |
| Per capita income (dollars per person) | 23,638 | 23,713 | 0.32 | 23,712 | 0.31 | 23,707 | 0.29 | 23,694 | 0.24 | 23,694 | 0.24 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; NT ESD 1991d.

**TABLE D.3–24.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Nevada Test Site Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 485,977 | 495,457 | 1.95 | 495,064 | 1.87 | 499,670 | 2.82 | 491,994 | 1.24 | 478,263 | 0.77 |
| Unemployment rate (percent) | 5.0 | 3.9 | NA | 3.9 | NA | 3.9 | NA | 4.0 | NA | 4.3 | NA |
| Per capita income (dollars per person) | 22,778 | 23,002 | 0.98 | 23,006 | 1.00 | 22,963 | 0.81 | 22,994 | 0.95 | 22,591 | 0.66 |
| **Operation** | | | | | | | | | | | |
| Total employment | 515,568 | 521,095 | 1.07 | 521,035 | 1.06 | 520,795 | 1.01 | 520,176 | 0.89 | 520,176 | 0.89 |
| Unemployment rate (percent) | 5.0 | 4.3 | NA | 4.3 | NA | 4.4 | NA | 4.4 | N/A | 4.4 | N/A |
| Per capita income (dollars per person) | 23,638 | 23,767 | 0.55 | 23,766 | 0.54 | 23,761 | 0.52 | 23,749 | 0.47 | 23,749 | 0.47 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NT ESD 1991d.

**TABLE D.3–25.—*Population for Nevada Test Site Region-of-Influence, 1970-2020***

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Clark County | 273,288 | 463,087 | 741,459 | 930,909 | 996,551 | 1,077,272 |
| Henderson | 16,395 | 24,363 | 64,942 | 81,535 | 87,285 | 94,355 |
| Las Vegas | 125,787 | 164,674 | 258,295 | 324,292 | 347,159 | 375,279 |
| North Las Vegas | 36,216 | 42,739 | 47,707 | 59,897 | 64, 120 | 69,314 |
| Nye County | 5,599 | 9,048 | 17,781 | 22,765 | 24,328 | 26,250 |
| **Total ROI** | 278,887 | 472,135 | 759,240 | 953,674 | 1,020,879 | 1,103,522 |

Source: Census 1973a; Census 1977a; Census 1983a; NT Census 1991a.

**TABLE D.3–26.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Nevada Test Site Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Clark County | 930,909 | 935,918 | 0.54 | 935,151 | 0.46 | 944,156 | 1.42 | 932,276 | 0.15 | 906,301 | 0.05 |
| Henderson | 81,535 | 81,824 | 0.35 | 81,780 | 0.30 | 82,298 | 0.94 | 81,614 | 0.10 | 79,368 | 0.03 |
| Las Vegas | 324,292 | 328,565 | 1.32 | 327,911 | 1.12 | 335,593 | 3.48 | 325,458 | 0.36 | 315,932 | 0.11 |
| North Las Vegas | 59,897 | 60,301 | 0.67 | 60,239 | 0.57 | 60,967 | 1.79 | 60,007 | 0.18 | 58,320 | 0.06 |
| Nye County | 22,765 | 23,703 | 4.12 | 23,560 | 3.49 | 25,246 | 10.90 | 23,021 | 1.12 | 22,248 | 0.36 |
| **Total ROI Construction** | 953,674 | 959,621 | 0.62 | 958,711 | 0.53 | 969,402 | 1.65 | 955,297 | 0.17 | 928,549 | 0.05 |
| **Operation** | | | | | | | | | | | |
| Clark County | 996,551 | 997,935 | 0.14 | 997,890 | 0.13 | 997,712 | 0.12 | 997,255 | 0.07 | 997,255 | 0.07 |
| Henderson | 87,285 | 87,365 | 0.09 | 87,362 | 0.09 | 87,352 | 0.08 | 87,326 | 0.05 | 87,326 | 0.05 |
| Las Vegas | 347,159 | 348,340 | 0.34 | 348,302 | 0.33 | 348,150 | 0.29 | 347,760 | 0.17 | 347,760 | 0.17 |
| North Las Vegas | 64,120 | 64,232 | 0.17 | 64,228 | 0.17 | 64,214 | 0.15 | 64,177 | 0.09 | 64,177 | 0.09 |
| Nye County | 24,328 | 24,587 | 1.06 | 24,579 | 1.03 | 24,546 | 0.90 | 24,460 | 0.54 | 24,460 | 0.54 |
| **Total ROI Operation** | 1,020,879 | 1,022,522 | 0.16 | 1,022,469 | 0.16 | 1,022,258 | 0.14 | 1,021,715 | 0.08 | 1,021,715 | 0.08 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; NT Census 1991a.

**TABLE D.3–27.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Changes (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Clark County | 930,909 | 938,255 | 0.79 | 937,487 | 0.71 | 946,507 | 1.68 | 932,911 | 0.22 | 906,648 | 0.08 |
| Henderson | 81,535 | 81,958 | 0.52 | 81,914 | 0.46 | 82,433 | 1.10 | 81,651 | 0.14 | 79,388 | 0.06 |
| Las Vegas | 324,292 | 330,558 | 1.93 | 329,904 | 1.73 | 337,599 | 4.10 | 326,000 | 0.53 | 316,229 | 0.21 |
| North Las Vegas | 59,897 | 60,490 | 0.99 | 60,428 | 0.89 | 61,156 | 2.10 | 60,058 | 0.27 | 58,348 | 0.11 |
| Nye County | 22,765 | 24,141 | 6.04 | 23,997 | 5.41 | 25,686 | 12.83 | 23,140 | 1.65 | 22,313 | 0.65 |
| **Total ROI Construction** | 953,674 | 962,396 | 0.91 | 961,484 | 0.82 | 972,193 | 1.94 | 956,051 | 0.25 | 928,961 | 0.10 |
| **Operation** | | | | | | | | | | | |
| Clark County | 996,551 | 999,957 | 0.34 | 999,912 | 0.34 | 999,735 | 0.32 | 999,277 | 0.27 | 999,277 | 0.27 |
| Henderson | 87,285 | 87,481 | 0.22 | 87,478 | 0.22 | 87,468 | 0.21 | 87,442 | 0.18 | 87,442 | 0.18 |
| Las Vegas | 347,159 | 350,065 | 0.84 | 350,027 | 0.83 | 349,875 | 0.78 | 349,484 | 0.67 | 349,484 | 0.67 |
| North Las Vegas | 64,120 | 64,395 | 0.43 | 64,392 | 0.42 | 64,377 | 0.40 | 64,340 | 0.34 | 64,340 | 0.34 |
| Nye County | 24,328 | 24,966 | 2.62 | 24,958 | 2.59 | 24,924 | 2.45 | 24,838 | 2.10 | 24,838 | 2.10 |
| **Total ROI Operation** | 1,020,879 | 1,024,923 | 0.40 | 1,024,870 | 0.39 | 1,024,659 | 0.37 | 1,024,115 | 0.32 | 1,024,115 | 0.32 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NT Census 1991a.

**TABLE D.3–28.—*Total Housing Units for Nevada Test Site Region-of-Influence, 1970-2020***

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Clark County | 93,047 | 190,607 | 317,188 | 398,233 | 426,314 | 460,845 |
| Henderson | 4,915 | 8,889 | 25,400 | 31,890 | 34,139 | 36,904 |
| Las Vegas | 43,054 | 67,133 | 109,670 | 137,692 | 147,401 | 159,340 |
| North Las Vegas | 10,416 | 14,123 | 15,837 | 19,884 | 21,285 | 23,010 |
| Nye County | 2,098 | 4,292 | 8,073 | 10,336 | 11,045 | 11,918 |
| **Total ROI** | 95,145 | 194,899 | 325,261 | 408,569 | 437,359 | 472,763 |

Source: Census 1972a; Census 1973a; Census 1977a; Census 1982a; Census 1983a; NT Census 1991a.

**TABLE D.3–29.—*Changes in Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Nevada Test Site Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Clark County | 398,233 | 400,137 | 0.48 | 399,846 | 0.41 | 403,270 | 1.26 | 398,752 | 0.13 | 387,686 | 0.04 |
| Henderson | 31,890 | 32,000 | 0.34 | 31,983 | 0.29 | 32,180 | 0.91 | 31,920 | 0.09 | 31,042 | 0.03 |
| Las Vegas | 137,692 | 139,317 | 1.18 | 139,068 | 1.00 | 141,989 | 3.12 | 138,135 | 0.32 | 134,126 | 0.10 |
| North Las Vegas | 19,884 | 20,037 | 0.77 | 20,014 | 0.65 | 20,291 | 2.05 | 19,925 | 0.21 | 19,362 | 0.07 |
| Nye County | 10,336 | 10,693 | 3.45 | 10,638 | 2.92 | 11,279 | 9.13 | 10,433 | 0.94 | 10,095 | 0.30 |
| **Total ROI Construction** | 408,569 | 410,830 | 0.55 | 410,484 | 0.47 | 414,549 | 1.46 | 409,186 | 0.15 | 397,781 | 0.05 |
| **Operation** | | | | | | | | | | | |
| Clark County | 426,314 | 426,840 | 0.12 | 426,823 | 0.12 | 426,755 | 0.10 | 426,581 | 0.06 | 426,581 | 0.06 |
| Henderson | 34,139 | 34,169 | 0.09 | 34,168 | 0.09 | 34,164 | 0.07 | 34,154 | 0.05 | 34,154 | 0.05 |
| Las Vegas | 147,401 | 147,850 | 0.30 | 147,836 | 0.29 | 147,778 | 0.26 | 147,629 | 0.16 | 147,629 | 0.16 |
| North Las Vegas | 21,286 | 21,328 | 0.20 | 21,327 | 0.19 | 21,321 | 0.17 | 21,307 | 0.10 | 21,307 | 0.10 |
| Nye County | 11,046 | 11,144 | 0.89 | 11,141 | 0.86 | 11,128 | 0.75 | 11,096 | 0.45 | 11,096 | 0.45 |
| **Total ROI Operation** | 437,359 | 437,984 | 0.14 | 437,964 | 0.14 | 437,883 | 0.12 | 437,677 | 0.07 | 437,677 | 0.07 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; NT Census 1991a.

TABLE D.3–30.—*Changes in Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Clark County | 398,233 | 401,026 | 0.70 | 400,734 | 0.63 | 404,163 | 1.49 | 398,994 | 0.19 | 387,817 | 0.08 |
| Henderson | 31,890 | 32,051 | 0.50 | 32,034 | 0.45 | 32,231 | 1.07 | 31,934 | 0.14 | 31,050 | 0.06 |
| Las Vegas | 137,692 | 140,074 | 1.73 | 139,826 | 1.55 | 142,751 | 3.67 | 138,341 | 0.47 | 134,239 | 0.19 |
| North Las Vegas | 19,884 | 20,109 | 1.13 | 20,086 | 1.02 | 20,362 | 2.41 | 19,945 | 0.31 | 19,372 | 0.12 |
| Nye County | 10,336 | 10,859 | 5.06 | 10,804 | 4.53 | 11,447 | 10.74 | 10,478 | 1.38 | 10,120 | 0.55 |
| **Total ROI Construction** | 408,569 | 411,885 | 0.81 | 411,538 | 0.73 | 415,610 | 1.72 | 409,472 | 0.22 | 397,937 | 0.09 |
| **Operation** | | | | | | | | | | | |
| Clark County | 426,314 | 427,609 | 0.30 | 427,591 | 0.30 | 427,524 | 0.28 | 427,350 | 0.24 | 427,350 | 0.24 |
| Henderson | 34,139 | 34,213 | 0.22 | 34,212 | 0.22 | 34,208 | 0.20 | 34,198 | 0.18 | 34,198 | 0.18 |
| Las Vegas | 147,401 | 148,506 | 0.75 | 148,491 | 0.74 | 148,434 | 0.70 | 148,285 | 0.60 | 148,285 | 0.60 |
| North Las Vegas | 21,286 | 21,390 | 0.49 | 21,389 | 0.49 | 21,383 | 0.46 | 21,369 | 0.39 | 21,369 | 0.39 |
| Nye County | 11,046 | 11,288 | 2.20 | 11,285 | 2.17 | 11,272 | 2.05 | 11,239 | 1.76 | 11,239 | 1.76 |
| **Total ROI Operation** | 437,359 | 438,897 | 0.35 | 438,877 | 0.35 | 438,796 | 0.33 | 438,589 | 0.28 | 438,589 | 0.28 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NT Census 1991a.

**TABLE D.3–31.—*County and City Revenues and Expenditures for Nevada Test Site Region-of-Influence, 1992***

| Revenues and Expenditures | Clark County | Henderson | Las Vegas | North Las Vegas | Nye County |
|---|---|---|---|---|---|
| Ad valorem taxes and special assessment (percent) | 25 | 21 | 22 | 17 | 18 |
| Intergovernmental (percent) | 39 | 51 | 51 | 55 | 66 |
| Permits, fees, fines, and investment interest (percent) | 34 | 24 | 24 | 22 | 10 |
| Other | 2 | 4 | 4 | 6 | 5 |
| **Total Revenues (dollars)** | 527,235,584 | 38,301,218 | 165,653,374 | 32,129,650 | 22,214,620 |
| General Government (percent) | 30 | 24 | 24 | 17 | 46 |
| Public safety, health, and community service (percent) | 48 | 43 | 51 | 68 | 36 |
| Public works, parks, culture, and recreation (percent) | 12 | 18 | 17 | 10 | 17 |
| Debt service (percent) | 10 | 15 | 7 | 5 | 1 |
| Other (percent) | 0 | 1 | 2 | 0 | 1 |
| **Total Expenditures (dollars)** | 440,571,167 | 37,804,113 | 156,464,143 | 35,936,420 | 19,819,986 |
| **End-of-Year Fund Balance (dollars)** | 292,589,218 | 11,785,009 | 52,674,187 | 2,802,631 | 9,504,516 |

Source: NT City 1992a; NT County 1992b.

**TABLE D.3–32.—*School District Revenues and Expenditures for Nevada Test Site Region-of-Influence, 1992***

| Revenues and Expenditures | Clark County School District | Nye County School District |
|---|---|---|
| Local sources (percent) | 56 | 55 |
| State sources (percent) | 41 | 42 |
| Federal sources (percent) | 3 | 3 |
| **Total Revenues (dollars)** | 612,625,040 | 20,964,283 |
| Total expenditures per pupil (dollars) | 4,999 | 6,244 |
| Instructional programs (percent) | 59 | 52 |
| School administration, services, and transportation (percent) | 32 | 18 |
| Maintenance, operation, and facilities acquisition (percent) | 0 | 13 |
| Debt service (percent) | 9 | 17 |
| **Total Expenditures (dollars)** | 625,721,294 | 21,206,033 |
| **End-of-Year Fund Balance (dollars)** | 61,326,714 | 2,671,943 |

Source: NT School 1992a.

**TABLE D.3–33.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies for Nevada Test Site Region-of-Influence, 2005 (2003 for Phased APT)***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Clark County | 470,864,564 | 472,986,283 | 0.45 | 472,764,202 | 0.40 | 475,370,516 | 0.96 | 471,744,234 | 0.19 | 464,141,739 | 0.08 |
| Henderson | 36,172,899 | 36,265,990 | 0.26 | 36,251,736 | 0.22 | 36,419,094 | 0.68 | 36,198,304 | 0.07 | 35,707,598 | 0.02 |
| Las Vegas | 171,479,001 | 171,909,837 | 0.25 | 171,843,865 | 0.21 | 172,618,411 | 0.66 | 171,596,577 | 0.07 | 169,351,402 | 0.02 |
| North Las Vegas | 31,988,776 | 32,056,742 | 0.21 | 32,046,334 | 0.18 | 32,168,522 | 0.56 | 32,007,324 | 0.06 | 31,652,919 | 0.02 |
| Nye County | 20,643,251 | 21,063,855 | 2.04 | 21,013,375 | 1.79 | 21,608,293 | 4.67 | 20,798,169 | 0.75 | 20,465,971 | 0.31 |
| **Total ROI County and City Revenues** | 731,148,491 | 734,282,706 | 0.43 | 733,919,512 | 0.38 | 738,184,836 | 0.96 | 732,344,609 | 0.16 | 721,319,630 | 0.07 |
| Clark County School District | 574,221,722 | 577,311,451 | 0.54 | 576,838,335 | 0.46 | 582,392,977 | 1.42 | 575,064,921 | 0.15 | 559,042,508 | 0.05 |
| Nye County School District | 23,117,186 | 24,069,356 | 4.12 | 23,924,146 | 3.49 | 25,636,205 | 10.90 | 23,376,815 | 1.12 | 22,591,867 | 0.36 |
| **Total ROI School District Revenues** | 597,338,909 | 601,380,807 | 0.68 | 600,762,481 | 0.57 | 608,029,182 | 1.79 | 598,441,736 | 0.18 | 581,634,375 | 0.06 |
| **Expenditures** | | | | | | | | | | | |
| Clark County | 467,347,399 | 469,649,651 | 0.49 | 469,297,118 | 0.42 | 473,436,052 | 1.30 | 467,975,692 | 0.13 | 455,958,977 | 0.04 |
| Henderson | 39,472,155 | 39,651,393 | 0.45 | 39,623,947 | 0.38 | 39,946,177 | 1.20 | 39,521,070 | 0.12 | 38,593,446 | 0.04 |
| Las Vegas | 173,001,945 | 173,881,793 | 0.51 | 173,747,066 | 0.43 | 175,328,836 | 1.35 | 173,242,059 | 0.14 | 168,678,178 | 0.04 |
| North Las Vegas | 34,411,539 | 34,589,971 | 0.52 | 34,562,648 | 0.44 | 34,883,428 | 1.37 | 34,460,234 | 0.14 | 33,537,690 | 0.04 |
| Nye County | 21,325,240 | 22,186,044 | 4.04 | 22,054,768 | 3.42 | 23,602,546 | 10.68 | 21,559,956 | 1.10 | 20,852,717 | 0.35 |
| **Total ROI County and City Expenditures** | 735,558,279 | 739,958,852 | 0.60 | 739,285,547 | 0.51 | 747,197,038 | 1.58 | 736,759,011 | 0.16 | 717,621,007 | 0.03 |
| Clark County School District | 560,778,199 | 562,590,699 | 0.32 | 562,313,159 | 0.27 | 565,571,629 | 0.85 | 561,272,837 | 0.09 | 551,952,097 | 0.03 |
| Nye County School District | 21,718,565 | 22,476,933 | 3.49 | 22,361,279 | 2.96 | 23,724,872 | 9.24 | 21,925,349 | 0.95 | 21,301,291 | 0.30 |
| **Total ROI School District Expenditures** | 582,496,763 | 585,067,632 | 0.44 | 584,674,438 | 0.37 | 589,296,501 | 1.17 | 583,198,186 | 0.12 | 573,253,388 | 0.04 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; NT City 1992a; NT County 1992b; NT ESD 1991a; NT School 1992a.

**TABLE D.3–34.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies for Nevada Test Site Region-of-Influence, 2010***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Clark County | 489,301,418 | 489,944,322 | 0.13 | 489,927,120 | 0.13 | 489,858,145 | 0.11 | 489,681,265 | 0.08 | 489,681,265 | 0.08 |
| Henderson | 37,391,611 | 37,417,332 | 0.07 | 37,416,495 | 0.07 | 37,413,187 | 0.06 | 37,404,694 | 0.03 | 37,404,694 | 0.03 |
| Las Vegas | 177,124,019 | 177,243,056 | 0.07 | 177,239,185 | 0.07 | 177,223,875 | 0.06 | 177,184,567 | 0.03 | 177,184,567 | 0.03 |
| North Las Vegas | 32,880,105 | 32,898,883 | 0.06 | 32,898,273 | 0.06 | 32,895,858 | 0.05 | 32,889,657 | 0.03 | 32,889,657 | 0.03 |
| Nye County | 21,352,697 | 21,482,163 | 0.61 | 21,478,404 | 0.59 | 21,464,080 | 0.52 | 21,426,419 | 0.35 | 21,426,419 | 0.35 |
| **Total ROI County and City Revenues** | 758,049,849 | 758,985,756 | 0.12 | 758,959,477 | 0.12 | 758,855,145 | 0.11 | 758,586,601 | 0.07 | 758,586,601 | 0.07 |
| Clark County School District | 614,712,333 | 615,566,004 | 0.14 | 615,538,246 | 0.13 | 615,428,449 | 0.12 | 615,146,553 | 0.07 | 615,146,553 | 0.07 |
| Nye County School District | 24,704,043 | 24,967,019 | 1.06 | 24,958,896 | 1.03 | 24,925,386 | 0.9 | 24,838,056 | 0.54 | 24,838,056 | 0.54 |
| **Total ROI School District Revenues** | 639,416,375 | 640,533,023 | 0.17 | 640,497,142 | 0.17 | 640,353,834 | 0.15 | 639,984,609 | 0.09 | 639,984,609 | 0.09 |
| **Expenditures** | | | | | | | | | | | |
| Clark County | 497,476,660 | 498,112,757 | 0.13 | 498,092,074 | 0.12 | 498,010,260 | 0.11 | 497,800,211 | 0.07 | 497,800,211 | 0.07 |
| Henderson | 41,821,383 | 41,870,905 | 0.12 | 41,869,295 | 0.11 | 41,862,926 | 0.10 | 41,846,573 | 0.06 | 41,846,573 | 0.06 |
| Las Vegas | 184,529,136 | 184,772,232 | 0.13 | 184,764,327 | 0.13 | 184,733,061 | 0.11 | 184,652,786 | 0.07 | 184,652,786 | 0.07 |
| North Las Vegas | 36,749,765 | 36,799,065 | 0.13 | 36,797,462 | 0.13 | 36,791,121 | 0.11 | 36,774,841 | 0.07 | 36,774,841 | 0.07 |
| Nye County | 22,760,331 | 22,998,074 | 1.04 | 22,990,730 | 1.01 | 22,960,435 | 0.88 | 22,881,486 | 0.53 | 22,881,486 | 0.53 |
| **Total ROI County and City Expenditures** | 783,337,276 | 784,553,033 | 0.16 | 784,513,888 | 0.15 | 784,357,803 | 0.13 | 783,955,897 | 0.08 | 783,955,897 | 0.08 |
| Clark County School District | 584,491,173 | 584,991,954 | 0.09 | 584,975,671 | 0.08 | 584,911,261 | 0.07 | 584,745,895 | 0.04 | 584,745,895 | 0.04 |
| Nye County School District | 22,981,958 | 23,191,409 | 0.91 | 23,184,939 | 0.88 | 23,158,249 | 0.77 | 23,088,695 | 0.46 | 23,088,695 | 0.46 |
| **Total ROI School District Expenditures** | 607,473,131 | 608,183,363 | 0.12 | 608,160,610 | 0.11 | 608,069,511 | 0.10 | 607,834,590 | 0.06 | 607,834,590 | 0.06 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; NT City 1992a; NT County 1992b; NT ESD 1991a; NT School 1992a.

TABLE D.3–35.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Clark County | 470,864,564 | 473,662,783 | 0.59 | 473,440,473 | 0.55 | 476,050,228 | 1.10 | 472,030,377 | 0.25 | 464,361,703 | 0.13 |
| Henderson | 36,172,899 | 36,309,424 | 0.38 | 36,295,150 | 0.34 | 36,462,787 | 0.80 | 36,210,105 | 0.10 | 35,714,047 | 0.04 |
| Las Vegas | 171,479,001 | 172,110,849 | 0.37 | 172,044,791 | 0.33 | 172,820,628 | 0.78 | 171,651,196 | 0.10 | 169,381,249 | 0.04 |
| North Las Vegas | 31,988,776 | 32,088,452 | 0.31 | 32,078,031 | 0.28 | 32,200,422 | 0.66 | 32,015,940 | 0.08 | 31,657,627 | 0.03 |
| Nye County | 20,643,251 | 21,218,340 | 2.79 | 21,167,550 | 2.54 | 21,763,399 | 5.43 | 20,853,734 | 1.02 | 20,505,046 | 0.50 |
| **Total ROI County and City Revenues** | 731,148,491 | 735,389,848 | 0.58 | 735,025,996 | 0.53 | 739,297,463 | 1.11 | 732,761,351 | 0.22 | 721,619,672 | 0.11 |
| Clark County School District | 574,221,722 | 578,753,006 | 0.79 | 578,279,273 | 0.71 | 583,843,168 | 1.68 | 575,456,614 | 0.22 | 559,256,551 | 0.08 |
| Nye County School District | 23,117,186 | 24,514,126 | 6.04 | 24,367,900 | 5.41 | 26,083,006 | 12.83 | 23,497,654 | 1.65 | 22,657,872 | 0.65 |
| **Total ROI School District Revenues** | 597,338,909 | 603,267,132 | 0.99 | 602,647,173 | 0.89 | 609,926,173 | 2.11 | 598,954,268 | 0.27 | 581,914,423 | 0.11 |
| **Expenditures** | | | | | | | | | | | |
| Clark County | 467,347,399 | 470,723,798 | 0.72 | 470,370,805 | 0.65 | 474,516,634 | 1.53 | 468,267,555 | 0.20 | 456,118,467 | 0.08 |
| Henderson | 39,472,155 | 39,735,019 | 0.67 | 39,707,537 | 0.60 | 40,030,303 | 1.41 | 39,543,792 | 0.18 | 38,605,863 | 0.07 |
| Las Vegas | 173,001,945 | 174,292,298 | 0.75 | 174,157,395 | 0.67 | 175,741,800 | 1.58 | 173,353,600 | 0.20 | 168,739,130 | 0.08 |
| North Las Vegas | 34,411,539 | 34,673,220 | 0.76 | 34,645,862 | 0.68 | 34,967,176 | 1.61 | 34,482,854 | 0.21 | 33,550,051 | 0.08 |
| Nye County | 21,325,240 | 22,588,136 | 5.92 | 22,455,941 | 5.30 | 24,006,473 | 12.57 | 21,669,200 | 1.61 | 20,912,388 | 0.64 |
| **Total ROI County and City Expenditures** | 735,558,279 | 742,012,471 | 0.88 | 741,337,541 | 0.79 | 749,262,387 | 1.86 | 737,317,001 | 0.24 | 717,925,898 | 0.09 |
| Clark County School District | 560,778,199 | 563,436,345 | 0.47 | 563,158,443 | 0.42 | 566,422,341 | 1.01 | 561,502,612 | 0.13 | 552,077,659 | 0.05 |
| Nye County School District | 21,718,565 | 22,831,176 | 5.12 | 22,714,713 | 4.59 | 24,080,732 | 10.88 | 22,021,593 | 1.40 | 21,353,861 | 0.55 |
| **Total ROI School District Expenditures** | 582,496,763 | 586,267,521 | 0.65 | 585,873,156 | 0.58 | 590,503,073 | 1.37 | 583,524,206 | 0.18 | 573,431,520 | 0.07 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NT City 1992a; NT County 1992b; NT ESD 1991a; NT School 1992a.

TABLE D.3–36.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling for Nevada Test Site Region-of-Influence, 2010*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Clark County | 489,301,418 | 490,726,614 | 0.29 | 490,709,287 | 0.29 | 490,640,791 | 0.27 | 490,463,557 | 0.24 | 490,463,557 | 0.24 |
| Henderson | 37,391,611 | 37,454,910 | 0.17 | 37,454,074 | 0.17 | 37,450,785 | 0.16 | 37,442,273 | 0.14 | 37,442,273 | 0.14 |
| Las Vegas | 177,124,019 | 177,416,974 | 0.17 | 177,413,103 | 0.16 | 177,397,879 | 0.15 | 177,358,485 | 0.13 | 177,358,485 | 0.13 |
| North Las Vegas | 32,880,105 | 32,926,320 | 0.14 | 32,925,709 | 0.14 | 32,923,307 | 0.13 | 32,917,093 | 0.11 | 32,917,093 | 0.11 |
| Nye County | 21,352,697 | 21,647,498 | 1.38 | 21,643,995 | 1.36 | 21,629,105 | 1.29 | 21,591,699 | 1.12 | 21,591,699 | 1.12 |
| **Total ROI County and City Revenues** | 758,049,849 | 760,172,316 | 0.28 | 760,146,168 | 0.28 | 760,041,867 | 0.26 | 759,773,106 | 0.23 | 759,773,106 | 0.23 |
| Clark County School District | 614,712,333 | 616,813,254 | 0.34 | 616,785,496 | 0.34 | 616,676,316 | 0.32 | 616,393,803 | 0.27 | 616,393,803 | 0.27 |
| Nye County School District | 24,704,043 | 25,351,877 | 2.62 | 25,343,753 | 2.59 | 25,309,228 | 2.45 | 25,221,899 | 2.10 | 25,221,899 | 2.10 |
| **Total ROI School District Revenues** | 639,416,375 | 642,165,131 | 0.43 | 642,129,250 | 0.42 | 641,985,543 | 0.40 | 641,615,702 | 0.34 | 641,615,702 | 0.34 |
| **Expenditures** | | | | | | | | | | | |
| Clark County | 497,476,660 | 499,042,121 | 0.31 | 499,021,438 | 0.31 | 498,940,084 | 0.29 | 498,729,576 | 0.25 | 498,729,576 | 0.25 |
| Henderson | 41,821,383 | 41,943,259 | 0.29 | 41,941,649 | 0.29 | 41,935,315 | 0.27 | 41,918,927 | 0.23 | 41,918,927 | 0.23 |
| Las Vegas | 184,529,136 | 185,127,405 | 0.32 | 185,119,501 | 0.32 | 185,088,410 | 0.30 | 185,007,960 | 0.26 | 185,007,960 | 0.26 |
| North Las Vegas | 36,749,765 | 36,871,093 | 0.33 | 36,869,490 | 0.33 | 36,863,185 | 0.31 | 36,846,870 | 0.26 | 36,846,870 | 0.26 |
| Nye County | 22,760,331 | 23,346,003 | 2.57 | 23,338,659 | 2.54 | 23,307,446 | 2.40 | 23,228,497 | 2.06 | 23,228,497 | 2.06 |
| **Total ROI County and City Expenditures** | 783,337,276 | 786,329,882 | 0.38 | 786,290,737 | 0.38 | 786,134,441 | 0.36 | 785,731,829 | 0.31 | 785,731,829 | 0.31 |
| Clark County School District | 584,491,173 | 585,723,617 | 0.21 | 585,707,334 | 0.21 | 585,643,286 | 0.20 | 585,477,559 | 0.17 | 585,477,559 | 0.17 |
| Nye County School District | 22,981,958 | 23,497,935 | 2.25 | 23,491,464 | 2.22 | 23,463,966 | 2.10 | 23,394,411 | 1.79 | 23,394,411 | 1.79 |
| **Total ROI School District Expenditures** | 607,473,131 | 609,221,552 | 0.29 | 609,198,798 | 0.28 | 609,107,253 | 0.27 | 608,871,970 | 0.23 | 608,871,970 | 0.23 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; NT City 1992a; NT County 1992b; NT ESD 1991a; NT School 1992a .

**TABLE D.3–37.—*Distribution of Employees by Place of Residence for Oak Ridge Reservation, 1991***

| County/City | Number of Employees | Total Site Employment (percent) |
|---|---|---|
| Anderson County | 5,757 | 34.7 |
| Clinton | 1,211 | 7.3 |
| Oak Ridge | 3,673 | 22.1 |
| Knox County | 6,113 | 36.8 |
| Knoxville | 5,427 | 32.7 |
| Loudon County | 941 | 5.7 |
| Lenoir City | 700 | 4.2 |
| Roane County | 2,807 | 16.9 |
| Harriman | 868 | 5.2 |
| Kingston | 1,162 | 7.0 |
| **Total ROI (County)** | 15,618 | 94.1 |

Source: ORR 1991a:4.

**TABLE D.3–38.—*Employment and Local Economy Statistics for Oak Ridge Reservation Economic Study Area, 1970-2020***

| Economic Study Area | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Civilian labor force | 349,630 | 460,364 | 525,461 | 597,924 | 611,220 | 602,822 |
| Total employment | 331,160 | 420,732 | 492,634 | 560,570 | 573,036 | 565,162 |
| Unemployment rate (percent) | 5.3 | 8.6 | 6.2 | 6.2 | 6.2 | 6.2 |
| Personal income (thousand dollars) | 2,461,301 | 7,971,913 | 16,196,884 | 23,562,265 | 25,332,874 | 28,160,468 |
| Per capita income (dollars per person) | 2,782 | 7,398 | 14,325 | 18,574 | 19,414 | 20,678 |

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; OR DES 1991a.

**TABLE D.3–39.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Oak Ridge Reservation Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 560,570 | 567,828 | 1.29 | 567,484 | 1.23 | 571,520 | 1.95 | 564,793 | 0.75 | 557,807 | 0.39 |
| Unemployment rate (percent) | 6.2 | 5.3 | NA | 5.3 | NA | 4.9 | NA | 5.6 | NA | 5.9 | NA |
| Per capita income (dollars per person) | 18,574 | 18,744 | 0.92 | 18,738 | 0.88 | 18,812 | 1.28 | 18,683 | 0.59 | 18,304 | 0.30 |
| **Operation** | | | | | | | | | | | |
| Total employment | 573,036 | 575,658 | 0.46 | 575,602 | 0.45 | 575,376 | 0.41 | 574,801 | 0.31 | 574,801 | 0.31 |
| Unemployment rate (percent) | 6.2 | 5.9 | NA | 5.9 | NA | 6.0 | NA | 6.0 | NA | 6.0 | NA |
| Per capita income (dollars per person) | 19,414 | 19,473 | 0.30 | 19,472 | 0.30 | 19,467 | 0.27 | 19,454 | 0.21 | 19,454 | 0.21 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; OR DES 1991a.

**TABLE D.3–40.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 560,570 | 568,891 | 1.48 | 568,547 | 1.42 | 572,590 | 2.14 | 565,851 | 0.94 | 558,857 | 0.58 |
| Unemployment rate (percent) | 6.2 | 5.2 | NA | 5.2 | NA | 4.8 | NA | 5.5 | NA | 5.8 | NA |
| Per capita income (dollars per person) | 18,574 | 18,764 | 1.02 | 18,757 | 0.99 | 18,832 | 1.39 | 18,708 | 0.72 | 18,332 | 0.45 |
| **Operation** | | | | | | | | | | | |
| Total employment | 573,036 | 578,241 | 0.91 | 578,184 | 0.90 | 577,958 | 0.86 | 577,375 | 0.76 | 577,375 | 0.76 |
| Unemployment rate (percent) | 6.2 | 5.6 | NA | 5.6 | NA | 5.6 | NA | 5.7 | NA | 5.7 | NA |
| Per capita income (dollars per person) | 19,414 | 19,532 | 0.61 | 19,531 | 0.60 | 19,526 | 0.58 | 19,512 | 0.51 | 19,512 | 0.51 |

Note: NA - not applicable

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995b; OR DES 1991a.

TABLE D.3–41.—*Population for Oak Ridge Reservation Region-of-Influence, 1970-2020*

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Anderson County | 60,300 | 67,346 | 68,250 | 77,346 | 79,708 | 83,295 |
| Clinton | 4,794 | 5,245 | 8,972 | 10,168 | 10,478 | 10,950 |
| Oak Ridge | 28,319 | 27,662 | 27,310 | 30,950 | 31,895 | 33,330 |
| Knox County | 276,293 | 319,694 | 335,749 | 380,343 | 391,956 | 409,594 |
| Knoxville | 174,587 | 175,030 | 165,121 | 187,052 | 192,764 | 201,438 |
| Loudon County | 24,266 | 28,553 | 31,255 | 34,276 | 35,156 | 36,632 |
| Lenoir City | 5,324 | 5,446 | 6,147 | 6,741 | 6,914 | 7,205 |
| Roane County | 38,881 | 48,425 | 47,227 | 52,860 | 54,217 | 56,495 |
| Harriman | 8,734 | 8,303 | 7,119 | 7,968 | 8,173 | 8,516 |
| Kingston | 4,142 | 4,441 | 4,552 | 5,095 | 5,226 | 5,445 |
| **Total ROI (County)** | 399,740 | 464,018 | 482,481 | 544,825 | 561,037 | 586,016 |

Source: Census 1973a; Census 1977a; Census 1983a; OR Census 1991a.

**TABLE D.3–42.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Oak Ridge Reservation Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Anderson County | 77,346 | 78,370 | 1.32 | 78,280 | 1.21 | 79,341 | 2.58 | 77,705 | 0.46 | 76,604 | 0.24 |
| Clinton | 10,168 | 10,395 | 2.23 | 10,375 | 2.04 | 10,611 | 4.36 | 10,248 | 0.79 | 10,087 | 0.41 |
| Oak Ridge | 30,950 | 31,583 | 2.05 | 31,528 | 1.87 | 32,184 | 3.99 | 31,172 | 0.72 | 30,692 | 0.37 |
| Knox County | 380,343 | 381,447 | 0.29 | 381,350 | 0.26 | 382,493 | 0.57 | 380,730 | 0.10 | 375,991 | 0.05 |
| Knoxville | 187,052 | 188,024 | 0.52 | 187,938 | 0.47 | 188,945 | 1.01 | 187,393 | 0.18 | 184,988 | 0.09 |
| Loudon County | 34,276 | 34,448 | 0.50 | 34,433 | 0.46 | 34,611 | 0.98 | 34,336 | 0.18 | 33,961 | 0.09 |
| Lenoir City | 6,741 | 6,870 | 1.91 | 6,859 | 1.75 | 6,992 | 3.72 | 6,786 | 0.67 | 6,696 | 0.34 |
| Roane County | 52,860 | 53,368 | 0.96 | 53,323 | 0.88 | 53,849 | 1.87 | 53,038 | 0.34 | 52,418 | 0.17 |
| Harriman | 7,968 | 8,131 | 2.05 | 8,117 | 1.87 | 8,286 | 3.99 | 8,026 | 0.73 | 7,917 | 0.37 |
| Kingston | 5,095 | 5,298 | 3.98 | 5,280 | 3.63 | 5,490 | 7.75 | 5,166 | 1.39 | 5,079 | 0.70 |
| **Total ROI Construction** | 544,825 | 547,633 | 0.52 | 547,386 | 0.47 | 550,294 | 1.00 | 545,809 | 0.18 | 538,974 | 0.09 |
| **Operation** | | | | | | | | | | | |
| Anderson County | 79,708 | 80,154 | 0.56 | 80,145 | 0.55 | 80,107 | 0.50 | 80,007 | 0.38 | 80,007 | 0.38 |
| Clinton | 10,478 | 10,577 | 0.94 | 10,575 | 0.92 | 10,567 | 0.85 | 10,545 | 0.64 | 10,545 | 0.64 |
| Oak Ridge | 31,895 | 32,171 | 0.87 | 32,165 | 0.85 | 32,142 | 0.77 | 32,080 | 0.58 | 32,080 | 0.58 |
| Knox County | 391,956 | 392,437 | 0.12 | 392,427 | 0.12 | 392,386 | 0.11 | 392,279 | 0.08 | 392,279 | 0.08 |
| Knoxville | 192,764 | 193,188 | 0.22 | 193,179 | 0.22 | 193,142 | 0.20 | 193,048 | 0.15 | 193,048 | 0.15 |
| Loudon County | 35,156 | 35,231 | 0.21 | 35,229 | 0.21 | 35,223 | 0.19 | 35,206 | 0.14 | 35,206 | 0.14 |
| Lenoir City | 6,914 | 6,970 | 0.81 | 6,969 | 0.79 | 6,964 | 0.72 | 6,952 | 0.55 | 6,952 | 0.55 |
| Roane County | 54,217 | 54,438 | 0.41 | 54,434 | 0.40 | 54,415 | 0.36 | 54,365 | 0.27 | 54,365 | 0.27 |
| Harriman | 8,173 | 8,244 | 0.87 | 8,243 | 0.86 | 8,236 | 0.77 | 8,221 | 0.59 | 8,221 | 0.59 |
| Kingston | 5,226 | 5,314 | 1.69 | 5,313 | 1.67 | 5,305 | 1.52 | 5,285 | 1.13 | 5,285 | 1.13 |
| **Total ROI Operation** | 561,038 | 562,260 | 0.22 | 562,235 | 0.21 | 562,131 | 0.19 | 561,857 | 0.15 | 561,857 | 0.15 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; OR Census 1991a.

**TABLE D.3–43.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Anderson County | 77,346 | 78,645 | 1.68 | 78,555 | 1.56 | 79,612 | 2.93 | 77,850 | 0.65 | 76,693 | 0.36 |
| Clinton | 10,168 | 10,456 | 2.83 | 10,436 | 2.64 | 10,671 | 4.95 | 10,280 | 1.10 | 10,107 | 0.61 |
| Oak Ridge | 30,950 | 31,753 | 2.59 | 31,698 | 2.42 | 32,352 | 4.53 | 31,261 | 1.00 | 30,748 | 0.55 |
| Knox County | 380,343 | 381,743 | 0.37 | 381,646 | 0.34 | 382,786 | 0.64 | 380,886 | 0.14 | 376,087 | 0.08 |
| Knoxville | 187,052 | 188,285 | 0.66 | 188,199 | 0.61 | 189,202 | 1.15 | 187,530 | 0.26 | 185,073 | 0.14 |
| Loudon County | 34,276 | 34,494 | 0.64 | 34,479 | 0.59 | 34,657 | 1.11 | 34,361 | 0.25 | 33,976 | 0.14 |
| Lenoir City | 6,741 | 6,905 | 2.43 | 6,893 | 2.25 | 7,027 | 4.24 | 6,804 | 0.93 | 6,707 | 0.51 |
| Roane County | 52,860 | 53,504 | 1.22 | 53,459 | 1.13 | 53,983 | 2.12 | 53,110 | 0.47 | 52,462 | 0.26 |
| Harriman | 7,968 | 8,175 | 2.60 | 8,161 | 2.42 | 8,329 | 4.53 | 8,049 | 1.02 | 7,931 | 0.55 |
| Kingston | 5,095 | 5,352 | 5.04 | 5,334 | 4.69 | 5,544 | 8.81 | 5,195 | 1.96 | 5,097 | 1.06 |
| **Total ROI Construction** | 544,825 | 548,386 | 0.65 | 548,139 | 0.61 | 551,038 | 1.14 | 546,207 | 0.25 | 539,218 | 0.14 |
| **Operation** | | | | | | | | | | | |
| Anderson County | 79,708 | 80,591 | 1.11 | 80,582 | 1.10 | 80,544 | 1.05 | 80,445 | 0.92 | 80,445 | 0.92 |
| Clinton | 10,478 | 10,674 | 1.87 | 10,672 | 1.85 | 10,664 | 1.77 | 10,642 | 1.56 | 10,642 | 1.56 |
| Oak Ridge | 31,895 | 32,441 | 1.71 | 32,436 | 1.70 | 32,412 | 1.62 | 32,351 | 1.43 | 32,351 | 1.43 |
| Knox County | 391,956 | 392,908 | 0.24 | 392,898 | 0.24 | 392,857 | 0.23 | 392,750 | 0.20 | 392,750 | 0.20 |
| Knoxville | 192,764 | 193,602 | 0.43 | 193,593 | 0.43 | 193,557 | 0.41 | 193,463 | 0.36 | 193,463 | 0.36 |
| Loudon County | 35,156 | 35,305 | 0.42 | 35,303 | 0.42 | 35,297 | 0.40 | 35,280 | 0.35 | 35,280 | 0.35 |
| Lenoir City | 6,914 | 7,025 | 1.60 | 7,024 | 1.59 | 7,019 | 1.52 | 7,007 | 1.34 | 7,007 | 1.34 |
| Roane County | 54,217 | 54,655 | 0.81 | 54,650 | 0.80 | 54,631 | 0.76 | 54,582 | 0.67 | 54,582 | 0.67 |
| Harriman | 8,173 | 8,314 | 1.73 | 8,312 | 1.70 | 8,306 | 1.63 | 8,290 | 1.43 | 8,290 | 1.43 |
| Kingston | 5,226 | 5,401 | 3.35 | 5,399 | 3.31 | 5,392 | 3.18 | 5,372 | 2.80 | 5,372 | 2.80 |
| **Total ROI Operation** | 561,038 | 563,459 | 0.43 | 563,433 | 0.43 | 563,329 | 0.41 | 563,057 | 0.36 | 563,057 | 0.36 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; OR Census 1991a.

**TABLE D.3–44.—*Total Housing Units for Oak Ridge Reservation Region-of-Influence, 1970-2020***

| Region-of-Influence | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Anderson County | 20,451 | 25,849 | 29,323 | 33,231 | 34,246 | 35,787 |
| Clinton | 1,702 | 2,073 | 4,006 | 4,540 | 4,678 | 4,889 |
| Oak Ridge | 9,972 | 11,487 | 11,664 | 13,219 | 13,622 | 14,235 |
| Knox County | 93,011 | 125,883 | 143,582 | 162,653 | 167,619 | 175,162 |
| Knoxville | 61,042 | 73,263 | 76,453 | 86,607 | 89,252 | 93,268 |
| Loudon County | 8,439 | 10,835 | 12,995 | 14,251 | 14,617 | 15,231 |
| Lenoir City | 1,982 | 2,342 | 2,734 | 2,998 | 3,075 | 3,205 |
| Roane County | 13,189 | 18,732 | 20,334 | 22,760 | 23,344 | 24,324 |
| Harriman | 3,132 | 3,355 | 3,234 | 3,620 | 3,173 | 3,869 |
| Kingston | 1,366 | 1,813 | 2,071 | 2,318 | 2,378 | 2,477 |
| **Total ROI (County)** | 135,090 | 181,299 | 206,234 | 232,895 | 239,826 | 250,504 |

Source: Census 1972a; Census 1973a; Census 1977a; Census 1982a; Census 1983a; OR Census 1991a.

TABLE D.3–45.—*Changes in Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Oak Ridge Reservation Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Anderson County | 33,231 | 33,620 | 1.17 | 33,586 | 1.07 | 33,990 | 2.28 | 33,368 | 0.41 | 32,903 | 0.21 |
| Clinton | 4,540 | 4,626 | 1.90 | 4,619 | 1.73 | 4,708 | 3.71 | 4,570 | 0.67 | 4,501 | 0.35 |
| Oak Ridge | 13,219 | 13,459 | 1.82 | 13,438 | 1.66 | 13,688 | 3.55 | 13,303 | 0.64 | 13,103 | 0.33 |
| Knox County | 162,653 | 163,072 | 0.26 | 163,035 | 0.24 | 163,470 | 0.50 | 162,800 | 0.09 | 160,782 | 0.05 |
| Knoxville | 86,607 | 86,977 | 0.43 | 86,944 | 0.39 | 87,327 | 0.83 | 86,737 | 0.15 | 85,637 | 0.08 |
| Loudon County | 14,251 | 14,316 | 0.46 | 14,311 | 0.42 | 14,378 | 0.89 | 14,274 | 0.16 | 14,119 | 0.08 |
| Lenoir City | 2,998 | 3,047 | 1.64 | 3,043 | 1.50 | 3,094 | 3.19 | 3,015 | 0.58 | 2,977 | 0.29 |
| Roane County | 22,760 | 22,953 | 0.85 | 22,935 | 0.77 | 23,135 | 1.65 | 22,827 | 0.29 | 22,564 | 0.15 |
| Harriman | 3,620 | 3,682 | 1.70 | 3,676 | 1.56 | 3,741 | 3.33 | 3,642 | 0.60 | 3,594 | 0.31 |
| Kingston | 2,318 | 2,395 | 3.33 | 2,388 | 3.04 | 2,468 | 6.48 | 2,345 | 1.17 | 2,308 | 0.59 |
| **Total ROI Construction** | 232,895 | 233,962 | 0.46 | 233,868 | 0.42 | 234,973 | 0.89 | 233,268 | 0.16 | 230,369 | 0.08 |
| **Operation** | | | | | | | | | | | |
| Anderson County | 34,246 | 34,415 | 0.50 | 34,412 | 0.49 | 34,398 | 0.44 | 34,360 | 0.33 | 34,360 | 0.33 |
| Clinton | 4,679 | 4,716 | 0.80 | 4,715 | 0.79 | 4,712 | 0.72 | 4,704 | 0.54 | 4,704 | 0.54 |
| Oak Ridge | 13,622 | 13,727 | 0.77 | 13,725 | 0.75 | 13,716 | 0.69 | 13,693 | 0.52 | 13,693 | 0.52 |
| Knox County | 167,619 | 167,802 | 0.11 | 167,798 | 0.11 | 167,782 | 0.10 | 167,742 | 0.07 | 167,742 | 0.07 |
| Knoxville | 89,252 | 89,413 | 0.18 | 89,410 | 0.18 | 89,396 | 0.16 | 89,360 | 0.12 | 89,360 | 0.12 |
| Loudon County | 14,617 | 14,645 | 0.20 | 14,645 | 0.19 | 14,642 | 0.17 | 14,636 | 0.13 | 14,636 | 0.13 |
| Lenoir City | 3,075 | 3,096 | 0.69 | 3,096 | 0.68 | 3,094 | 0.62 | 3,090 | 0.47 | 3,090 | 0.47 |
| Roane County | 23,344 | 23,428 | 0.36 | 23,426 | 0.35 | 23,419 | 0.32 | 23,400 | 0.24 | 23,400 | 0.24 |
| Harriman | 3,713 | 3,740 | 0.73 | 3,739 | 0.72 | 3,737 | 0.65 | 3,731 | 0.49 | 3,731 | 0.49 |
| Kingston | 2,378 | 2,411 | 1.41 | 2,411 | 1.39 | 2,408 | 1.27 | 2,400 | 0.95 | 2,400 | 0.95 |
| **Total ROI Operation** | 239,825 | 240,290 | 0.19 | 240,281 | 0.19 | 240,241 | 0.17 | 240,137 | 0.13 | 240,137 | 0.13 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; OR Census 1991a.

**TABLE D.3–46.—*Changes in Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Anderson County | 33,231 | 33,725 | 1.49 | 33,691 | 1.38 | 34,093 | 2.59 | 33,423 | 0.58 | 32,937 | 0.31 |
| Clinton | 4,540 | 4,650 | 2.41 | 4,642 | 2.24 | 4,731 | 4.21 | 4,583 | 0.94 | 4,509 | 0.52 |
| Oak Ridge | 13,219 | 13,524 | 2.31 | 13,503 | 2.15 | 13,752 | 4.03 | 13,337 | 0.89 | 13,124 | 0.49 |
| Knox County | 162,653 | 163,185 | 0.33 | 163,148 | 0.30 | 163,581 | 0.57 | 162,859 | 0.13 | 160,819 | 0.07 |
| Knoxville | 86,607 | 87,076 | 0.54 | 87,043 | 0.50 | 87,425 | 0.94 | 86,789 | 0.21 | 85,670 | 0.11 |
| Loudon County | 14,251 | 14,334 | 0.58 | 14,328 | 0.54 | 14,396 | 1.02 | 14,283 | 0.23 | 14,125 | 0.12 |
| Lenoir City | 2,998 | 3,061 | 2.09 | 3,056 | 1.93 | 3,107 | 3.63 | 3,022 | 0.81 | 2,981 | 0.43 |
| Roane County | 22,760 | 23,004 | 1.07 | 22,987 | 1.00 | 23,186 | 1.87 | 22,854 | 0.41 | 22,581 | 0.23 |
| Harriman | 3,620 | 3,698 | 2.17 | 3,693 | 2.02 | 3,757 | 3.78 | 3,650 | 0.84 | 3,600 | 0.46 |
| Kingston | 2,318 | 2,416 | 4.22 | 2,409 | 3.92 | 2,489 | 7.37 | 2,356 | 1.64 | 2,315 | 0.88 |
| **Total ROI Construction** | 232,895 | 234,248 | 0.58 | 234,154 | 0.54 | 235,256 | 1.01 | 233,419 | 0.23 | 230,461 | 0.12 |
| **Operation** | | | | | | | | | | | |
| Anderson County | 34,246 | 34,582 | 0.98 | 34,578 | 0.97 | 34,564 | 0.93 | 34,526 | 0.82 | 34,526 | 0.82 |
| Clinton | 4,679 | 4,753 | 1.59 | 4,752 | 1.57 | 4,749 | 1.51 | 4,741 | 1.33 | 4,741 | 1.33 |
| Oak Ridge | 13,622 | 13,830 | 1.52 | 13,828 | 1.51 | 13,819 | 1.44 | 13,796 | 1.27 | 13,796 | 1.27 |
| Knox County | 167,619 | 167,981 | 0.22 | 167,977 | 0.21 | 167,961 | 0.20 | 167,921 | 0.18 | 167,921 | 0.18 |
| Knoxville | 89,252 | 89,571 | 0.36 | 89,567 | 0.35 | 89,554 | 0.34 | 89,518 | 0.30 | 89,518 | 0.30 |
| Loudon County | 14,617 | 14,674 | 0.39 | 14,673 | 0.38 | 14,671 | 0.37 | 14,664 | 0.32 | 14,664 | 0.32 |
| Lenoir City | 3,075 | 3,117 | 1.37 | 3,117 | 1.36 | 3,115 | 1.30 | 3,111 | 1.15 | 3,111 | 1.15 |
| Roane County | 23,344 | 23,510 | 0.71 | 23,508 | 0.70 | 23,501 | 0.67 | 23,482 | 0.59 | 23,482 | 0.59 |
| Harriman | 3,713 | 3,766 | 1.45 | 3,766 | 1.43 | 3,763 | 1.36 | 3,757 | 1.20 | 3,757 | 1.20 |
| Kingston | 2,378 | 2,444 | 2.80 | 2,443 | 2.77 | 2,441 | 2.66 | 2,433 | 2.34 | 2,433 | 2.34 |
| **Total ROI Operation** | 239,825 | 240,746 | 0.38 | 240,736 | 0.38 | 240,697 | 0.36 | 240,593 | 0.32 | 240,593 | 0.32 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a OR Census 1991a.

TABLE D.3–47.—*County and City Revenues and Expenditures for Oak Ridge Reservation Region-of-Influence, 1992*

| Revenues and Expenditures | Anderson County | Clinton | Oak Ridge | Knox County | Knoxville | Loudon County | Lenoir City | Roane County | Harriman | Kingston |
|---|---|---|---|---|---|---|---|---|---|---|
| Property tax (percent) | 39 | 61 | 22 | 29 | 70 | 45 | 32 | 44 | 18 | 52 |
| Intergovernmental (percent) | 48 | 20 | 66 | 33 | 17 | 47 | 56 | 45 | 74 | 24 |
| Permits, fees, fines, and investment interest (percent) | 12 | 10 | 11 | 13 | 3 | 7 | 9 | 11 | 5 | 4 |
| Other (percent) | 1 | 8 | 1 | 25 | 9 | 1 | 4 | 0 | 3 | 20 |
| **Total Revenues (dollars)** | 41,134,071 | 4,731,541 | 34,657,938 | 311,946,751 | 111,859,759 | 19,807,853 | 8,800,080 | 28,691,069 | 8,956,445 | 1,915,214 |
| General government (percent) | 21 | 27 | 3 | 5 | 5 | 22 | 11 | 20 | 10 | 28 |
| Public safety, health, and community service (percent) | 0 | 18 | 21 | 9 | 32 | 0 | 10 | 0 | 10 | 25 |
| Public works, parks, culture, and recreation (public) | 5 | 25 | 5 | 3 | 26 | 6 | 10 | 6 | 7 | 45 |
| Debt service (percent) | 8 | 19 | 6 | 5 | 26 | 13 | 7 | 6 | 4 | 2 |
| Education (percent) | 53 | 0 | 61 | 42 | 0 | 56 | 62 | 67 | 67 | 0 |
| Other (percent) | 13 | 12 | 4 | 36 | 12 | 2 | 0 | 1 | 3 | 0 |
| **Total Expenditures (dollars)** | 44,923,778 | 4,844,783 | 38,742,383 | 437,684,259 | 126,182,092 | 21,695,020 | 8,518,830 | 29,054,426 | 9,571,068 | 1,634,203 |
| **End-of-Year Fund Balance (dollars)** | 7,885,051 | 5,149,098 | 26,401,105 | 109,551,335 | 31,917,343 | 2,323,795 | 1,959,558 | 16,222,017 | 3,443,762 | 413,930 |

Source: OR City 1992a; OR County 1992a.

TABLE D.3–48.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies for Oak Ridge Reservation Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Anderson County | 43,442,049 | 43,741,978 | 0.69 | 43,715,919 | 0.63 | 44,023,089 | 1.34 | 43,548,919 | 0.25 | 43,230,228 | 0.12 |
| Clinton | 5,036,437 | 5,083,775 | 0.94 | 5,079,668 | 0.86 | 5,128,076 | 1.82 | 5,053,340 | 0.34 | 5,001,925 | 0.17 |
| Oak Ridge | 39,066,506 | 39,551,576 | 1.24 | 39,509,274 | 1.13 | 40,007,924 | 2.41 | 39,238,445 | 0.44 | 38,739,207 | 0.23 |
| Knox County | 356,268,754 | 358,115,082 | 0.52 | 358,011,859 | 0.49 | 359,223,133 | 0.83 | 357,253,919 | 0.28 | 352,012,469 | 0.13 |
| Knoxville | 119,477,318 | 119,766,635 | 0.24 | 119,742,247 | 0.22 | 120,029,556 | 0.46 | 119,584,629 | 0.09 | 118,409,604 | 0.05 |
| Loudon County | 20,887,662 | 20,938,254 | 0.24 | 20,933,907 | 0.22 | 20,985,511 | 0.47 | 20,905,683 | 0.09 | 20,801,516 | 0.04 |
| Lenoir City | 9,006,611 | 9,025,235 | 0.21 | 9,023,620 | 0.19 | 9,042,793 | 0.40 | 9,013,159 | 0.07 | 8,972,071 | 0.04 |
| Roane County | 30,573,213 | 30,712,177 | 0.45 | 30,699,930 | 0.41 | 30,843,105 | 0.88 | 30,622,230 | 0.16 | 30,425,212 | 0.08 |
| Harriman | 9,003,994 | 9,020,993 | 0.19 | 9,019,491 | 0.17 | 9,037,051 | 0.37 | 9,009,968 | 0.07 | 8,985,785 | 0.03 |
| Kingston | 1,846,471 | 1,858,990 | 0.68 | 1,857,952 | 0.62 | 1,870,096 | 1.28 | 1,851,252 | 0.26 | 1,834,165 | 0.13 |
| **Total ROI County, City, School District Revenues** | 634,609,015 | 637,814,695 | 0.51 | 637,593,867 | 0.47 | 640,190,335 | 0.88 | 636,081,544 | 0.23 | 628,412,182 | 0.11 |
| **Expenditures** | | | | | | | | | | | |
| Anderson County | 46,106,174 | 46,378,827 | 0.59 | 46,354,856 | 0.54 | 46,637,445 | 1.15 | 46,201,710 | 0.21 | 45,886,904 | 0.10 |
| Clinton | 5,682,146 | 5,698,695 | 0.29 | 5,697,240 | 0.27 | 5,714,392 | 0.57 | 5,687,945 | 0.10 | 5,688,553 | 0.05 |
| Oak Ridge | 41,746,005 | 42,176,482 | 1.03 | 42,138,636 | 0.94 | 42,584,801 | 2.01 | 41,896,841 | 0.36 | 41,427,637 | 0.19 |
| Knox County | 485,281,724 | 486,544,702 | 0.26 | 486,433,729 | 0.24 | 487,741,372 | 0.51 | 485,724,422 | 0.09 | 480,360,384 | 0.04 |
| Knoxville | 125,439,503 | 125,622,129 | 0.15 | 125,606,082 | 0.13 | 125,795,167 | 0.28 | 125,503,517 | 0.05 | 124,638,710 | 0.03 |
| Loudon County | 22,480,305 | 22,527,668 | 0.21 | 22,523,541 | 0.19 | 22,572,515 | 0.41 | 22,496,853 | 0.07 | 22,397,263 | 0.04 |
| Lenoir City | 9,339,916 | 9,358,429 | 0.20 | 9,356,815 | 0.18 | 9,375,958 | 0.39 | 9,346,384 | 0.07 | 9,313,719 | 0.04 |
| Roane County | 30,397,924 | 30,533,497 | 0.45 | 30,521,476 | 0.41 | 30,661,990 | 0.87 | 30,445,342 | 0.16 | 30,269,896 | 0.07 |
| Harriman | 9,893,397 | 9,940,114 | 0.47 | 9,935,972 | 0.43 | 9,984,391 | 0.92 | 9,909,737 | 0.17 | 9,850,147 | 0.08 |
| Kingston | 1,809,609 | 1,822,245 | 0.70 | 1,821,125 | 0.64 | 1,834,222 | 1.36 | 1,814,028 | 0.24 | 1,799,268 | 0.13 |
| **Total ROI County, City, School District Expenditures** | 778,176,702 | 780,602,788 | 0.31 | 780,389,473 | 0.28 | 782,902,254 | 0.61 | 779,026,778 | 0.11 | 771,632,482 | 0.05 |

Source: Census 1973a; Census 1977a; Census 1983a, DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; OR City 1992a; OR County 1992a; OR DES 1991a.

TABLE D.3–49.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies for Oak Ridge Reservation Region-of-Influence, 2010*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Anderson County | 44,120,170 | 44,250,377 | 0.30 | 44,247,747 | 0.29 | 44,236,650 | 0.26 | 44,207,092 | 0.20 | 44,207,092 | 0.20 |
| Clinton | 5,142,635 | 5,163,176 | 0.40 | 5,162,761 | 0.39 | 5,161,011 | 0.36 | 5,156,340 | 0.27 | 5,156,340 | 0.27 |
| Oak Ridge | 40,172,946 | 40,383,766 | 0.52 | 40,379,509 | 0.51 | 40,361,543 | 0.47 | 40,313,871 | 0.35 | 40,313,871 | 0.35 |
| Knox County | 368,580,846 | 369,300,475 | 0.20 | 369,285,137 | 0.19 | 369,223,339 | 0.17 | 369,061,881 | 0.13 | 369,061,881 | 0.13 |
| Knoxville | 122,273,105 | 122,397,015 | 0.10 | 122,394,432 | 0.10 | 122,383,854 | 0.09 | 122,355,833 | 0.07 | 122,355,833 | 0.07 |
| Loudon County | 21,139,450 | 21,161,458 | 0.10 | 21,160,877 | 0.10 | 21,159,117 | 0.09 | 21,154,108 | 0.07 | 21,154,108 | 0.07 |
| Lenoir City | 9,101,214 | 9,109,343 | 0.09 | 9,109,128 | 0.09 | 9,108,479 | 0.08 | 9,106,638 | 0.06 | 9,106,638 | 0.06 |
| Roane County | 30,936,687 | 30,996,962 | 0.19 | 30,995,866 | 0.19 | 30,990,674 | 0.17 | 30,976,945 | 0.13 | 30,976,945 | 0.13 |
| Harriman | 9,047,999 | 9,055,378 | 0.08 | 9,055,244 | 0.08 | 9,054,609 | 0.07 | 9,052,931 | 0.05 | 9,052,931 | 0.05 |
| Kingston | 1,876,300 | 1,881,627 | 0.28 | 1,881,527 | 0.28 | 1,881,070 | 0.25 | 1,879,799 | 0.19 | 1,879,799 | 0.19 |
| **Total ROI County, City, School District Revenues** | 652,391,351 | 653,699,577 | 0.20 | 653,672,227 | 0.20 | 653,560,345 | 0.18 | 653,265,440 | 0.13 | 653,265,440 | 0.13 |
| **Expenditures** | | | | | | | | | | | |
| Anderson County | 46,731,808 | 46,850,601 | 0.25 | 46,848,204 | 0.25 | 46,838,083 | 0.23 | 46,811,448 | 0.17 | 46,811,448 | 0.17 |
| Clinton | 5,726,309 | 5,733,519 | 0.13 | 5,733,373 | 0.12 | 5,732,759 | 0.11 | 5,731,142 | 0.08 | 5,731,142 | 0.08 |
| Oak Ridge | 42,737,749 | 42,925,305 | 0.44 | 42,921,520 | 0.43 | 42,905,540 | 0.39 | 42,863,489 | 0.29 | 42,863,489 | 0.29 |
| Knox County | 498,577,349 | 499,127,204 | 0.11 | 499,115,764 | 0.11 | 499,068,858 | 0.10 | 498,946,445 | 0.07 | 498,946,445 | 0.07 |
| Knoxville | 127,372,659 | 127,452,168 | 0.06 | 127,450,513 | 0.06 | 127,443,731 | 0.06 | 127,426,030 | 0.04 | 127,426,030 | 0.04 |
| Loudon County | 22,724,592 | 22,745,300 | 0.09 | 22,744,750 | 0.09 | 22,743,099 | 0.08 | 22,738,422 | 0.06 | 22,738,422 | 0.06 |
| Lenoir City | 9,434,520 | 9,442,614 | 0.09 | 9,442,399 | 0.08 | 9,441,753 | 0.08 | 9,439,925 | 0.06 | 9,439,925 | 0.06 |
| Roane County | 30,758,558 | 30,817,475 | 0.19 | 30,816,407 | 0.19 | 30,811,331 | 0.17 | 30,797,974 | 0.13 | 30,797,974 | 0.13 |
| Harriman | 10,017,982 | 10,038,283 | 0.20 | 10,037,915 | 0.20 | 10,036,166 | 0.18 | 10,031,564 | 0.14 | 10,031,564 | 0.14 |
| Kingston | 1,843,302 | 1,848,793 | 0.30 | 1,848,694 | 0.29 | 1,848,221 | 0.27 | 1,846,976 | 0.20 | 1,846,976 | 0.20 |
| **Total ROI County, City, School District Expenditures** | 795,924,827 | 796,981,262 | 0.13 | 796,959,539 | 0.13 | 796,869,542 | 0.12 | 796,633,416 | 0.09 | 796,633,416 | 0.09 |

Source: Census 1973a; Census 1977a; Census 1983a, DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; OR City 1992a; OR County 1992a; OR DES 1991a.

**TABLE D.3–50.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence, 2005 (2003 for Phased APT)***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Anderson County | 43,442,049 | 43,821,602 | 0.87 | 43,795,548 | 0.81 | 44,101,577 | 1.52 | 43,591,431 | 0.34 | 43,256,742 | 0.18 |
| Clinton | 5,036,437 | 5,096,324 | 1.19 | 5,092,218 | 1.11 | 5,140,446 | 2.07 | 5,060,050 | 0.47 | 5,006,119 | 0.26 |
| Oak Ridge | 39,066,506 | 39,680,830 | 1.57 | 39,638,534 | 1.46 | 40,135,323 | 2.74 | 39,307,183 | 0.62 | 38,781,871 | 0.34 |
| Knox County | 356,268,754 | 358,431,164 | 0.61 | 358,328,028 | 0.58 | 359,539,056 | 0.92 | 357,520,620 | 0.35 | 352,256,069 | 0.20 |
| Knoxville | 119,477,318 | 119,841,109 | 0.30 | 119,816,722 | 0.28 | 120,103,343 | 0.52 | 119,625,633 | 0.12 | 118,436,236 | 0.07 |
| Loudon County | 20,887,662 | 20,951,595 | 0.31 | 20,947,248 | 0.29 | 20,998,852 | 0.53 | 20,913,033 | 0.12 | 20,806,009 | 0.06 |
| Lenoir City | 9,006,611 | 9,030,191 | 0.26 | 9,028,575 | 0.24 | 9,047,749 | 0.46 | 9,015,864 | 0.10 | 8,973,704 | 0.06 |
| Roane County | 30,573,213 | 30,749,201 | 0.58 | 30,736,952 | 0.54 | 30,879,588 | 1.00 | 30,641,952 | 0.22 | 30,437,361 | 0.12 |
| Harriman | 9,003,994 | 9,025,534 | 0.24 | 9,024,031 | 0.22 | 9,041,526 | 0.42 | 9,012,380 | 0.09 | 8,987,266 | 0.05 |
| Kingston | 1,846,471 | 1,862,135 | 0.85 | 1,861,095 | 0.79 | 1,873,198 | 1.45 | 1,853,035 | 0.36 | 1,835,350 | 0.20 |
| **Total ROI County, City, School District Revenues** | 634,609,015 | 638,489,685 | 0.61 | 638,268,952 | 0.58 | 640,860,658 | 0.99 | 636,541,181 | 0.30 | 628,776,728 | 0.17 |
| **Expenditures** | | | | | | | | | | | |
| Anderson County | 46,106,174 | 46,452,071 | 0.75 | 46,428,100 | 0.70 | 46,709,624 | 1.31 | 46,240,329 | 0.29 | 45,910,605 | 0.15 |
| Clinton | 5,682,146 | 5,703,141 | 0.37 | 5,701,686 | 0.34 | 5,718,773 | 0.64 | 5,690,289 | 0.14 | 5,689,992 | 0.08 |
| Oak Ridge | 41,746,005 | 42,292,123 | 1.31 | 42,254,277 | 1.22 | 42,698,760 | 2.28 | 41,957,815 | 0.51 | 41,465,063 | 0.28 |
| Knox County | 485,281,724 | 486,883,339 | 0.33 | 486,772,366 | 0.31 | 488,076,577 | 0.58 | 485,902,893 | 0.13 | 480,470,209 | 0.07 |
| Knoxville | 125,439,503 | 125,671,096 | 0.18 | 125,655,049 | 0.17 | 125,843,638 | 0.32 | 125,529,324 | 0.07 | 124,654,591 | 0.04 |
| Loudon County | 22,480,305 | 22,540,324 | 0.27 | 22,536,197 | 0.25 | 22,585,171 | 0.47 | 22,503,731 | 0.10 | 22,401,390 | 0.05 |
| Lenoir City | 9,339,916 | 9,363,376 | 0.25 | 9,361,762 | 0.23 | 9,380,905 | 0.44 | 9,349,072 | 0.10 | 9,315,332 | 0.05 |
| Roane County | 30,397,924 | 30,569,828 | 0.57 | 30,557,806 | 0.53 | 30,697,786 | 0.99 | 30,464,576 | 0.22 | 30,281,649 | 0.11 |
| Harriman | 9,893,397 | 9,952,633 | 0.60 | 9,948,491 | 0.56 | 9,996,726 | 1.04 | 9,916,365 | 0.23 | 9,854,198 | 0.13 |
| Kingston | 1,809,609 | 1,825,632 | 0.89 | 1,824,511 | 0.82 | 1,837,559 | 1.54 | 1,815,821 | 0.34 | 1,800,364 | 0.19 |
| **Total ROI County, City, School District Expenditures** | 778,176,702 | 781,253,562 | 0.40 | 781,040,247 | 0.37 | 783,545,519 | 0.69 | 779,370,215 | 0.15 | 771,843,392 | 0.08 |

Source: Census 1973a; Census 1977a; Census 1983a, DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; OR City 1992a; OR County 1992a; OR DES 1991a.

**TABLE D.3–51.—*Changes in County, City, and School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling for Oak Ridge Reservation Region-of-Influence, 2010***

| Region-of-Influence | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Anderson County | 44,120,170 | 44,377,960 | 0.58 | 44,375,329 | 0.58 | 44,364,232 | 0.55 | 44,335,330 | 0.49 | 44,335,330 | 0.49 |
| Clinton | 5,142,635 | 5,183,304 | 0.79 | 5,182,889 | 0.78 | 5,181,138 | 0.75 | 5,176,578 | 0.66 | 5,176,578 | 0.66 |
| Oak Ridge | 40,172,946 | 40,590,332 | 1.04 | 40,586,075 | 1.03 | 40,568,109 | 0.98 | 40,521,314 | 0.87 | 40,521,314 | 0.87 |
| Knox County | 368,580,846 | 370,006,998 | 0.39 | 369,991,635 | 0.38 | 369,929,774 | 0.37 | 369,769,912 | 0.32 | 369,769,912 | 0.32 |
| Knoxville | 122,273,105 | 122,518,495 | 0.20 | 122,515,912 | 0.20 | 122,505,334 | 0.19 | 122,477,747 | 0.17 | 122,477,747 | 0.17 |
| Loudon County | 21,139,450 | 21,183,096 | 0.21 | 21,182,515 | 0.20 | 21,180,756 | 0.20 | 21,175,787 | 0.17 | 21,175,787 | 0.17 |
| Lenoir City | 9,101,214 | 9,117,336 | 0.18 | 9,117,121 | 0.17 | 9,116,472 | 0.17 | 9,114,636 | 0.15 | 9,114,636 | 0.15 |
| Roane County | 30,936,687 | 31,056,264 | 0.39 | 31,054,900 | 0.38 | 31,049,706 | 0.37 | 31,036,315 | 0.32 | 31,036,315 | 0.32 |
| Harriman | 9,047,999 | 9,062,639 | 0.16 | 9,062,472 | 0.16 | 9,061,836 | 0.15 | 9,060,197 | 0.13 | 9,060,197 | 0.13 |
| Kingston | 1,876,300 | 1,886,867 | 0.56 | 1,886,748 | 0.56 | 1,886,288 | 0.53 | 1,885,104 | 0.47 | 1,885,104 | 0.47 |
| **Total ROI County, City, School District Revenues** | 652,391,351 | 654,983,292 | 0.40 | 654,955,595 | 0.39 | 654,843,647 | 0.38 | 654,552,920 | 0.33 | 654,552,920 | 0.33 |
| **Expenditures** | | | | | | | | | | | |
| Anderson County | 46,731,808 | 46,966,992 | 0.50 | 46,964,595 | 0.50 | 46,954,474 | 0.48 | 46,928,106 | 0.42 | 46,928,106 | 0.42 |
| Clinton | 5,726,309 | 5,740,583 | 0.25 | 5,740,438 | 0.25 | 5,739,824 | 0.24 | 5,738,223 | 0.21 | 5,738,223 | 0.21 |
| Oak Ridge | 42,737,749 | 43,109,069 | 0.87 | 43,105,284 | 0.86 | 43,089,305 | 0.82 | 43,047,674 | 0.73 | 43,047,674 | 0.73 |
| Knox County | 498,577,349 | 499,666,049 | 0.22 | 499,654,609 | 0.22 | 499,607,703 | 0.21 | 499,485,290 | 0.18 | 499,485,290 | 0.18 |
| Knoxville | 127,372,659 | 127,530,084 | 0.12 | 127,528,430 | 0.12 | 127,521,648 | 0.12 | 127,503,947 | 0.10 | 127,503,947 | 0.10 |
| Loudon County | 22,724,592 | 22,765,660 | 0.18 | 22,765,110 | 0.18 | 22,763,459 | 0.17 | 22,758,782 | 0.15 | 22,758,782 | 0.15 |
| Lenoir City | 9,434,520 | 9,450,572 | 0.17 | 9,450,357 | 0.17 | 9,449,712 | 0.16 | 9,447,883 | 0.14 | 9,447,883 | 0.14 |
| Roane County | 30,758,558 | 30,875,444 | 0.38 | 30,874,108 | 0.38 | 30,869,033 | 0.36 | 30,855,943 | 0.32 | 30,855,943 | 0.32 |
| Harriman | 10,017,982 | 10,058,259 | 0.40 | 10,057,798 | 0.40 | 10,056,049 | 0.38 | 10,051,539 | 0.33 | 10,051,539 | 0.33 |
| Kingston | 1,843,302 | 1,854,197 | 0.59 | 1,854,072 | 0.58 | 1,853,599 | 0.56 | 1,852,379 | 0.49 | 1,852,379 | 0.49 |
| **Total ROI County, City, School District Expenditures** | 795,924,827 | 798,016,910 | 0.26 | 797,994,802 | 0.26 | 797,904,805 | 0.25 | 797,669,766 | 0.22 | 797,669,766 | 0.22 |

Source: Census 1973a; Census 1977a; Census 1983a, DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; OR City 1992a; OR County 1992a; OR DES 1991a.

**TABLE D.3–52.—*Distribution of Employees by Place of Residence for Pantex Plant, 1991***

| County/City | Number of Employees | Total Site Employment (percent) |
|---|---|---|
| Carson County | 143 | 5.5 |
| Potter/Randall Counties | 2,203 | 84.9 |
| Amarillo[a] | 2,145 | 82.7 |
| **Total ROI (County)** | 2,346 | 90.4 |

[a] Amarillo is located in Potter County and Randall County.
Source: PX 1991a:5.

**TABLE D.3–53.—*Employment and Local Economy Statistics for Pantex Plant Economic Study Area, 1970-2020***

| Economic Study Area | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Civilian labor force | 110,508 | 138,326 | 158,111 | 174,336 | 176,176 | 169,690 |
| Total employment | 106,774 | 132,545 | 150,911 | 166,398 | 168,153 | 161,962 |
| Unemployment rate (percent) | 3.4 | 4.2 | 4.6 | 4.6 | 4.6 | 4.6 |
| Personal income (thousand dollars) | 1,105,838 | 2,956,763 | 5,485,191 | 7,569,413 | 7,980,631 | 8,620,287 |
| Per capita income (dollars per person) | 4,091 | 9,625 | 17,546 | 23,127 | 24,200 | 25,703 |

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; PX DOC 1991a.

**TABLE D.3–54.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Pantex Plant Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 166,398 | 173,008 | 3.97 | 172,694 | 3.78 | 176,370 | 5.99 | 170,244 | 2.31 | 167,651 | 1.18 |
| Unemployment rate (percent) | 4.6 | 2.2 | NA | 2.3 | NA | 2.2 | NA | 3.0 | NA | 3.7 | NA |
| Per capita income (dollars per person) | 23,127 | 23,535 | 1.76 | 23,529 | 1.74 | 23,378 | 1.09 | 23,398 | 1.17 | 22,878 | 0.74 |
| **Operation** | | | | | | | | | | | |
| Total employment | 168,153 | 170,842 | 1.60 | 170,784 | 1.56 | 170,553 | 1.43 | 169,957 | 1.07 | 169,957 | 1.07 |
| Unemployment rate (percent) | 4.6 | 3.4 | NA | 3.6 | NA | 3.9 | NA | 3.8 | NA | 3.8 | NA |
| Per capita income (dollars per person) | 24,200 | 24,436 | 0.98 | 24,431 | 0.95 | 24,410 | 0.69 | 24,358 | 0.65 | 24,358 | 0.65 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX DOC 1991a.

**TABLE D.3–55.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Pantex Plant Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Total employment | 166,398 | 173,962 | 4.55 | 173,649 | 4.36 | 177,324 | 6.57 | 171,199 | 2.89 | 168,606 | 1.75 |
| Unemployment rate (percent) | 4.6 | 2.2 | NA | 2.2 | NA | 2.2 | NA | 2.7 | NA | 3.3 | NA |
| Per capita income (dollars per person) | 23,127 | 23,490 | 1.56 | 23,504 | 1.63 | 23,325 | 0.86 | 23,450 | 1.40 | 22,932 | 0.97 |
| **Operation** | | | | | | | | | | | |
| Total employment | 168,153 | 173,473 | 3.16 | 173,416 | 3.13 | 173,184 | 2.99 | 172,589 | 2.64 | 172,589 | 2.64 |
| Unemployment rate (percent) | 4.6 | 2.5 | NA | 2.5 | NA | 2.7 | NA | 2.8 | NA | 2.8 | NA |
| Per capita income (dollars per person) | 24,200 | 24,594 | 1.62 | 24,591 | 1.62 | 24,555 | 1.47 | 24,546 | 1.43 | 24,546 | 1.43 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX DOC 1991a.

**TABLE D.3–56.—*Population for Pantex Plant Region-of-Influence, 1970-2020***

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Carson County | 6,358 | 6,672 | 6,576 | 6,766 | 6,793 | 6,888 |
| Potter County | 90,511 | 98,637 | 97,874 | 104,820 | 105,863 | 107,875 |
| Amarillo | 127,010 | 149,230 | 157,615 | 165,050 | 166,692 | 169,859 |
| Randall County | 53,885 | 75,062 | 89,673 | 91,573 | 92,485 | 94,242 |
| **ROI Total** | 150,754 | 180,371 | 194,123 | 203,159 | 205,141 | 209,005 |

Source: Census 1973a; Census 1977a; Census 1983a; PX Census 1991a.

**TABLE D.3–57.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Pantex Plant Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Carson County | 6,766 | 7,041 | 4.06 | 7,016 | 3.70 | 7,493 | 10.74 | 6,898 | 1.95 | 6,798 | 0.64 |
| Potter County | 104,820 | 107,327 | 2.39 | 107,096 | 2.17 | 111,453 | 6.33 | 106,028 | 1.15 | 104,801 | 0.38 |
| Amarillo | 165,050 | 169,183 | 2.50 | 168,802 | 2.27 | 175,983 | 6.62 | 167,041 | 1.21 | 165,049 | 0.40 |
| Randall County | 91,573 | 93,308 | 1.89 | 93,148 | 1.72 | 96,162 | 5.01 | 92,409 | 0.91 | 91,484 | 0.30 |
| **Total ROI Construction** | 203,159 | 207,676 | 2.22 | 207,260 | 2.02 | 215,108 | 5.88 | 205,335 | 1.07 | 203,083 | 0.35 |
| **Operation** | | | | | | | | | | | |
| Carson County | 6,793 | 6,866 | 1.08 | 6,865 | 1.07 | 6,858 | 0.96 | 6,842 | 0.73 | 6,842 | 0.73 |
| Potter County | 105,863 | 106,530 | 0.63 | 106,516 | 0.62 | 106,459 | 0.56 | 106,311 | 0.42 | 106,311 | 0.42 |
| Amarillo | 166,692 | 167,792 | 0.66 | 167,768 | 0.65 | 167,674 | 0.59 | 167,430 | 0.44 | 167,430 | 0.44 |
| Randall County | 92,485 | 92,947 | 0.50 | 92,937 | 0.49 | 92,897 | 0.45 | 92,795 | 0.34 | 92,795 | 0.34 |
| **Total ROI Operation** | 205,141 | 206,343 | 0.59 | 206,318 | 0.57 | 206,214 | 0.52 | 205,948 | 0.39 | 205,948 | 0.39 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX Census 1991a.

**TABLE D.3–58.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Carson County | 6,766 | 7,169 | 5.96 | 7,127 | 5.34 | 7,621 | 12.64 | 6,943 | 2.62 | 6,843 | 1.31 |
| Potter County | 104,820 | 108,498 | 3.51 | 108,114 | 3.14 | 112,624 | 7.45 | 106,438 | 1.54 | 105,212 | 0.77 |
| Amarillo | 165,050 | 171,112 | 3.67 | 170,479 | 3.29 | 177,913 | 7.79 | 167,717 | 1.62 | 165,726 | 0.81 |
| Randall County | 91,573 | 94,118 | 2.78 | 93,852 | 2.49 | 96,972 | 5.90 | 92,692 | 1.22 | 91,769 | 0.61 |
| **Total ROI Construction** | 203,159 | 209,785 | 3.26 | 209,093 | 2.92 | 217,217 | 6.92 | 206,073 | 1.43 | 203,824 | 0.72 |
| **Operation** | | | | | | | | | | | |
| Carson County | 6,793 | 6,996 | 3.00 | 6,993 | 2.95 | 6,980 | 2.76 | 6,943 | 2.22 | 6,943 | 2.22 |
| Potter County | 105,863 | 107,713 | 1.75 | 107,684 | 1.72 | 107,569 | 1.61 | 107,274 | 1.33 | 107,274 | 1.33 |
| Amarillo | 166,692 | 169,741 | 1.83 | 169,694 | 1.80 | 169,504 | 1.69 | 169,017 | 1.39 | 169,017 | 1.39 |
| Randall County | 92,485 | 93,765 | 1.38 | 93,745 | 1.36 | 93,665 | 1.28 | 93,461 | 1.06 | 93,461 | 1.06 |
| **Total ROI Operation** | 205,141 | 208,474 | 1.62 | 208,422 | 1.60 | 208,214 | 1.50 | 207,678 | 1.24 | 207,678 | 1.24 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX Census 1991a.

**TABLE D.3–59.—*Total Housing Units for Pantex Plant Region-of-Influence, 1970-2020***

| Jurisdiction | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Carson County | 2,333 | 2,635 | 2,856 | 2,938 | 2,950 | 2,992 |
| Potter County | 36,589 | 41,042 | 42,927 | 45,974 | 46,431 | 47,313 |
| Amarillo | 48,383 | 60,280 | 68,592 | 71,828 | 72,542 | 73,920 |
| Randall County | 17,346 | 28,544 | 37,807 | 38,608 | 38,992 | 39,733 |
| **Total ROI (County)** | 56,268 | 72,221 | 83,590 | 87,520 | 88,374 | 90,038 |

Source: Census 1972a; Census 1973a; Census 1977a; Census 1982a; PX Census 1991a.

**TABLE D.3–60.—*Changes to Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies for Pantex Plant Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Carson County | 2,938 | 3,043 | 3.58 | 3,034 | 3.24 | 3,215 | 9.43 | 2,989 | 1.73 | 2,950 | 0.56 |
| Potter County | 45,974 | 46,927 | 2.07 | 46,839 | 1.88 | 48,496 | 5.48 | 46,433 | 1.00 | 45,942 | 0.33 |
| Amarillo | 71,828 | 73,399 | 2.19 | 73,254 | 1.99 | 75,985 | 5.79 | 72,585 | 1.05 | 71,791 | 0.35 |
| Randall County | 38,608 | 39,268 | 1.71 | 39,207 | 1.55 | 40,353 | 4.52 | 38,926 | 0.82 | 38,559 | 0.27 |
| **Total ROI** | 87,520 | 89,238 | 1.96 | 89,079 | 1.78 | 92,063 | 5.19 | 88,347 | 0.95 | 87,451 | 0.31 |
| **Operation** | | | | | | | | | | | |
| Carson County | 2,950 | 2,978 | 0.95 | 2,978 | 0.93 | 2,975 | 0.84 | 2,969 | 0.64 | 2,969 | 0.64 |
| Potter County | 46,431 | 46,685 | 0.55 | 46,679 | 0.53 | 46,658 | 0.49 | 46,601 | 0.37 | 46,601 | 0.37 |
| Amarillo | 72,542 | 72,960 | 0.58 | 72,951 | 0.56 | 72,916 | 0.51 | 72,823 | 0.39 | 72,823 | 0.39 |
| Randall County | 38,992 | 39,168 | 0.45 | 39,164 | 0.44 | 39,149 | 0.40 | 39,110 | 0.30 | 39,110 | 0.30 |
| **Total ROI** | 88,374 | 88,831 | 0.52 | 88,821 | 0.51 | 88,782 | 0.46 | 88,681 | 0.35 | 88,681 | 0.35 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX Census 1991a.

**TABLE D.3–61.—*Changes in Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | |
| Carson County | 2,938 | 3,092 | 5.20 | 3,076 | 4.65 | 3,264 | 11.04 | 3,006 | 2.27 | 2,967 | 1.14 |
| Potter County | 45,974 | 47,372 | 3.04 | 47,226 | 2.72 | 48,941 | 6.46 | 46,589 | 1.34 | 46,098 | 0.67 |
| Amarillo | 71,828 | 74,133 | 3.21 | 73,892 | 2.87 | 76,718 | 6.81 | 72,842 | 1.41 | 72,049 | 0.71 |
| Randall County | 38,608 | 39,576 | 2.51 | 39,475 | 2.24 | 40,661 | 5.32 | 39,034 | 1.10 | 38,668 | 0.55 |
| **Total ROI Construction** | 87,520 | 90,039 | 2.88 | 89,776 | 2.58 | 92,865 | 6.11 | 88,628 | 1.27 | 87,733 | 0.63 |
| **Operation** | | | | | | | | | | | |
| Carson County | 2,950 | 3,027 | 2.62 | 3,026 | 2.58 | 3,021 | 2.42 | 3,007 | 1.94 | 3,007 | 1.94 |
| Potter County | 46,431 | 47,134 | 1.51 | 47,123 | 1.49 | 47,080 | 1.40 | 46,967 | 1.16 | 46,967 | 1.16 |
| Amarillo | 72,542 | 73,702 | 1.60 | 73,684 | 1.57 | 73,611 | 1.47 | 73,426 | 1.22 | 73,426 | 1.22 |
| Randall County | 38,992 | 39,479 | 1.25 | 39,472 | 1.23 | 39,441 | 1.15 | 39,364 | 0.95 | 39,364 | 0.95 |
| **Total ROI Operation** | 88,374 | 89,641 | 1.43 | 89,621 | 1.41 | 89,542 | 1.32 | 89,338 | 1.09 | 89,338 | 1.09 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX Census 1991a.

TABLE D.3–62.—*County and City Revenues and Expenditures for Pantex Plant Region-of-Influence, 1992*

| Revenues and Expenditures | Carson County | Potter County | Amarillo[a] | Randall County |
|---|---|---|---|---|
| Local sources (percent) | 73 | 69 | 59 | 63 |
| State revenues (percent) | 1 | 4 | 12 | 2 |
| Federal revenues (percent) | 20 | 20 | 19 | 31 |
| Other (percent) | 5 | 7 | 9 | 4 |
| **Total Revenues (dollars)** | 1,604,751 | 16,561,508 | 65,950,257 | 10,515,627 |
| General Government (percent) | 69 | 35 | 8 | 40 |
| Public safety, health, and community service (percent) | 18 | 39 | 45 | 34 |
| Public works, parks, culture, and recreation (percent) | 0 | 7 | 44 | 15 |
| Debt service (percent) | 0 | 7 | 2 | 6 |
| Other (percent) | 13 | 12 | 2 | 5 |
| **Total Expenditures (dollars)** | 2,343,195 | 19,967,949 | 59,656,411 | 10,426,496 |
| **End-of-Year Fund Balance (dollars)** | 17,988 | 396,766 | 19,822,447 | 1,8838,147 |

[a] Estimated from 1989-1991 financial audits and 1992 fiscal budgets.
Source: PX City 1991a; PX County 1992a.

TABLE D.3–63.—*School District Revenues and Expenditures for Pantex Region-of-Influence, 1992*

| | Carson County | | | Potter County | Randall County |
|---|---|---|---|---|---|
| Revenues and Expenditures | Groom Independent School District | Panhandle Independent School District | White Deer Independent School District | Amarillo Independent School District | Canyon Independent School District |
| Local sources (percent) | 56 | 85 | 92 | 46 | 47 |
| State revenues (percent) | 40 | 12 | 5 | 47 | 49 |
| Federal revenues (percent) | 5 | 3 | 3 | 7 | 4 |
| **Total Revenues (dollars)** | 1,341,890 | 4,240,134 | 2,809,639 | 112,974,576 | 23,512,715 |
| Total expenditures per pupil (dollars) | 6,208 | 5,717 | 5,542 | 3,950 | 3,953 |
| Total instruction (percent) | 55 | 57 | 52 | 59 | 57 |
| School administration, services, and transportation (percent) | 32 | 25 | 29 | 23 | 23 |
| Maintenance, operation, and facilities acquisition (percent) | 13 | 13 | 19 | 11 | 10 |
| Other (percent) | 0 | 5 | 0 | 7 | 11 |
| **Total Expenditures (dollars)** | 1,334,657 | 3,984,495 | 2,687,654 | 107,836,850 | 23,205,181 |
| **End-of-Year Fund Balance (dollars)** | 635,058 | 1,718,148 | 995,296 | 20,591,936 | 4,701,437 |

Source: PX School 1992a.

TABLE D.3–64.—*Changes in County and City Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies for Pantex Plant Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Carson County | 1,629,404 | 1,696,223 | 4.10 | 1,690,624 | 3.76 | 1,793,232 | 10.05 | 1,662,661 | 2.04 | 1,638,484 | 0.74 |
| Potter County | 17,920,786 | 18,425,873 | 2.82 | 18,388,038 | 2.61 | 19,036,023 | 6.22 | 18,183,596 | 1.47 | 17,961,345 | 0.60 |
| Amarillo | 64,794,434 | 66,327,796 | 2.37 | 66,214,407 | 2.19 | 68,141,189 | 5.17 | 65,595,563 | 1.24 | 64,939,655 | 0.51 |
| Randall County | 9,857,208 | 10,127,355 | 2.74 | 10,108,601 | 2.55 | 10,415,161 | 5.66 | 10,001,137 | 1.46 | 9,880,274 | 0.63 |
| **Total ROI County and City Revenues** | 94,201,832 | 96,577,247 | 2.52 | 96,401,670 | 2.34 | 99,385,604 | 5.50 | 95,442,956 | 1.32 | 94,419,758 | 0.54 |
| **Expenditures** | | | | | | | | | | | |
| Carson County | 2,356,950 | 2,444,251 | 3.70 | 2,436,329 | 3.37 | 2,587,484 | 9.78 | 2,398,937 | 1.78 | 2,367,839 | 0.58 |
| Potter County | 19,039,510 | 19,440,077 | 2.10 | 19,403,161 | 1.91 | 20,099,440 | 5.57 | 19,232,487 | 1.01 | 19,036,845 | 0.33 |
| Amarillo | 56,736,350 | 57,843,984 | 1.95 | 57,741,969 | 1.77 | 59,666,525 | 5.16 | 57,269,903 | 0.94 | 56,715,086 | 0.31 |
| Randall County | 9,370,063 | 9,527,130 | 1.68 | 9,512,643 | 1.52 | 9,785,547 | 4.43 | 9,445,730 | 0.81 | 9,359,394 | 0.26 |
| **Total ROI County and City Expenditures** | 87,502,873 | 89,255,442 | 2.00 | 89,094,102 | 1.82 | 92,138,996 | 5.30 | 88,347,057 | 0.96 | 87,479,163 | 0.32 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX City 1992a; PX County 1992a; PX DOC 1991a.

TABLE D.3–65.—*Changes in County and City Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies for Pantex Plant Region-of-Influence, 2010*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Carson County | 1,634,445 | 1,653,811 | 1.18 | 1,653,500 | 1.17 | 1,651,721 | 1.06 | 1,647,468 | 0.80 | 1,647,468 | 0.80 |
| Potter County | 18,086,368 | 18,248,061 | 0.89 | 18,244,661 | 0.88 | 18,230,769 | 0.80 | 18,194,887 | 0.60 | 18,194,887 | 0.60 |
| Amarillo | 65,293,540 | 65,789,530 | 0.76 | 65,980,314 | 1.05 | 65,736,273 | 0.68 | 65,626,448 | 0.51 | 65,626,448 | 0.51 |
| Randall County | 9,952,042 | 10,043,439 | 0.92 | 10,117,758 | 1.67 | 10,033,572 | 0.82 | 10,013,389 | 0.62 | 10,013,389 | 0.62 |
| **Total ROI County and City Revenues** | 94,966,395 | 95,734,841 | 0.81 | 95,996,233 | 1.08 | 95,652,335 | 0.72 | 95,482,193 | 0.54 | 95,482,193 | 0.54 |
| **Expenditures** | | | | | | | | | | | |
| Carson County | 2,363,542 | 2,386,830 | 0.99 | 2,386,513 | 0.97 | 2,384,295 | 0.88 | 2,379,225 | 0.66 | 2,379,225 | 0.66 |
| Potter County | 19,205,843 | 19,312,362 | 0.55 | 19,310,124 | 0.54 | 19,301,015 | 0.50 | 19,277,364 | 0.37 | 19,277,364 | 0.37 |
| Amarillo | 57,220,243 | 57,515,135 | 0.52 | 57,754,233 | 0.93 | 57,483,500 | 0.46 | 57,418,269 | 0.35 | 57,418,269 | 0.35 |
| Randall County | 9,454,965 | 9,496,841 | 0.44 | 9,586,481 | 1.39 | 9,492,313 | 0.40 | 9,483,078 | 0.30 | 9,483,078 | 0.30 |
| **Total ROI County and City Expenditures** | 88,244,593 | 88,711,167 | 0.53 | 89,037,351 | 0.90 | 88,661,124 | 0.47 | 88,557,935 | 0.36 | 88,557,935 | 0.36 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX City 1992a; PX County 1992a; PX DOC 1991a.

**TABLE D.3–66.—*Changes in School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies for Pantex Plant Region-of-Influence, 2005 (2003 for Phased APT)***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Amarillo | 105,624,268 | 108,150,051 | 2.39 | 107,917,279 | 2.17 | 112,307,691 | 6.33 | 106,841,089 | 1.15 | 105,604,680 | 0.38 |
| Canyon | 20,628,469 | 21,018,206 | 1.89 | 20,983,716 | 1.72 | 21,663,169 | 5.02 | 20,818,164 | 0.92 | 20,607,775 | 0.30 |
| Groom | 1,187,445 | 1,235,799 | 4.07 | 1,231,411 | 3.70 | 1,315,132 | 10.75 | 1,210,701 | 1.96 | 1,193,149 | 0.64 |
| Panhandle | 4,172,331 | 4,342,234 | 4.07 | 4,326,816 | 3.70 | 4,620,985 | 10.75 | 4,254,045 | 1.96 | 4,192,374 | 0.64 |
| White Deer | 2,780,218 | 2,892,098 | 4.02 | 2,880,910 | 3.62 | 3,076,700 | 10.66 | 2,836,158 | 2.01 | 2,791,406 | 0.60 |
| **Total ROI School District Revenues** | 134,392,731 | 137,638,388 | 2.42 | 137,340,133 | 2.19 | 142,983,678 | 6.39 | 135,960,156 | 1.17 | 134,389,384 | 0.38 |
| **Expenditures** | | | | | | | | | | | |
| Amarillo | 98,658,883 | 100,550,299 | 1.92 | 100,375,989 | 1.74 | 103,663,720 | 5.07 | 99,570,092 | 0.92 | 98,617,798 | 0.30 |
| Canyon | 20,399,581 | 20,739,259 | 1.67 | 20,709,199 | 1.52 | 21,301,381 | 4.42 | 20,564,911 | 0.81 | 20,380,148 | 0.27 |
| Groom | 1,146,607 | $1,193,299 | 4.07 | 1,189,062 | 3.70 | 1,269,903 | 10.75 | 1,169,063 | 1.96 | 1,152,115 | 0.64 |
| Panhandle | 3,832,845 | 3,988,924 | 4.07 | 3,974,760 | 3.70 | 4,244,994 | 10.75 | 3,907,910 | 1.96 | 3,851,257 | 0.64 |
| White Deer | 2,644,040 | 2,750,440 | 4.02 | 2,739,800 | 3.62 | 2,926,000 | 10.66 | 2,697,240 | 2.01 | 2,654,680 | 0.60 |
| **Total ROI School District Expenditures** | 126,681,957 | 129,222,220 | 2.01 | 128,988,810 | 1.82 | 133,405,998 | 5.31 | 127,909,216 | 0.97 | 126,655,998 | 0.32 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX DOC 1991a; PX School 1992a.

**TABLE D.3–67.—*Changes in School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies for Pantex Plant Region-of-Influence, 2010***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Amarillo | 106,675,281 | 107,346,939 | 0.63 | 107,332,831 | 0.62 | 107,275,394 | 0.56 | 107,126,259 | 0.42 | 107,126,259 | 0.42 |
| Canyon | 20,835,409 | 20,938,879 | 0.50 | 21,163,064 | 0.50 | 20,928,532 | 0.45 | 20,904,389 | 0.33 | 20,904,389 | 0.33 |
| Groom | 1,192,185 | 1,205,084 | 1.08 | 1,204,909 | 1.07 | 1,203,680 | 0.96 | 1,200,872 | 0.73 | 1,200,872 | 0.73 |
| Panhandle | 4,188,987 | 4,234,310 | 1.08 | 4,233,693 | 1.07 | 4,229,376 | 0.96 | 4,219,509 | 0.73 | 4,219,509 | 0.73 |
| White Deer | 2,791,406 | 2,819,376 | 1.00 | 2,819,376 | 1.00 | 2,819,376 | 1.00 | 2,813,782 | 0.80 | 2,813,782 | 0.80 |
| **Total ROI School District Revenues** | 135,683,269 | 136,544,588 | 0.63 | 136,753,873 | 0.79 | 136,456,359 | 0.57 | 136,264,811 | 0.43 | 136,264,811 | 0.43 |
| **Expenditures** | | | | | | | | | | | |
| Amarillo | 99,442,090 | 99,945,057 | 0.51 | 99,934,492 | 0.50 | 99,891,481 | 0.45 | 99,779,802 | 0.34 | 99,779,802 | 0.34 |
| Canyon | 20,579,729 | 20,669,909 | 0.44 | 20,865,299 | 1.39 | 20,660,891 | 0.39 | 20,639,849 | 0.29 | 20,639,849 | 0.29 |
| Groom | 1,151,185 | 1,163,640 | 1.08 | 1,163,470 | 1.07 | 1,162,284 | 0.96 | 1,159,572 | 0.73 | 1,159,572 | 0.73 |
| Panhandle | 3,848,146 | 3,889,781 | 1.08 | 3,889,215 | 1.07 | 3,885,249 | 0.96 | 3,876,184 | 0.73 | 3,876,184 | 0.73 |
| White Deer | 2,654,680 | 2,681,280 | 1.00 | 2,681,280 | 1.00 | 2,681,280 | 1.00 | 2,675,960 | 0.80 | 2,675,960 | 0.80 |
| **Total ROI School District Expenditures** | 127,675,830 | 128,349,666 | 0.53 | 128,533,756 | 0.67 | 128,281,185 | 0.47 | 128,131,368 | 0.36 | 128,131,368 | 0.36 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX DOC 1991a; PX School 1992a.

TABLE D.3–68.—*Changes in County and City Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Carson County | 1,629,404 | 1,723,698 | 5.79 | 1,714,662 | 5.23 | 1,820,707 | 11.74 | 1,673,358 | 2.70 | 1,649,180 | 1.40 |
| Potter County | 17,920,786 | 18,599,205 | 3.79 | 18,542,249 | 3.47 | 19,209,132 | 7.19 | 18,262,487 | 1.91 | 18,040,360 | 1.04 |
| Amarillo | 64,794,434 | 66,842,410 | 3.16 | 66,673,464 | 2.90 | 68,655,804 | 5.96 | 65,834,204 | 1.60 | 65,178,994 | 0.88 |
| Randall County | 9,857,208 | 10,209,044 | 3.57 | 10,182,202 | 3.30 | 10,496,900 | 6.49 | 10,042,610 | 1.88 | 9,921,949 | 1.05 |
| **Total ROI County and City Revenues** | 94,201,832 | 97,374,191 | 3.37 | 97,112,577 | 3.09 | 100,182,542 | 6.35 | 95,812,658 | 1.71 | 94,790,484 | 0.93 |
| **Expenditures** | | | | | | | | | | | |
| Carson County | 2,356,950 | 2,484,813 | 5.42 | 2,471,504 | 4.86 | 2,628,045 | 11.50 | 2,413,197 | 2.39 | 2,382,099 | 1.19 |
| Potter County | 19,039,510 | 19,627,211 | 3.09 | 19,565,845 | 2.76 | 20,286,575 | 6.55 | 19,298,008 | 1.36 | 19,102,525 | 0.68 |
| Amarillo | 56,736,350 | 58,361,172 | 2.86 | 58,191,473 | 2.56 | 60,183,712 | 6.08 | 57,450,882 | 1.26 | 56,896,800 | 0.63 |
| Randall County | 9,370,063 | 9,600,472 | 2.46 | 9,576,387 | 2.20 | 9,858,889 | 5.22 | 9,471,354 | 1.08 | 9,385,199 | 0.54 |
| **Total ROI County and City Expenditures** | 87,502,873 | 90,073,667 | 2.94 | 89,805,208 | 2.63 | 92,957,221 | 6.23 | 88,633,441 | 1.29 | 87,766,624 | 0.65 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX City 1992a; PX County 1992a; PX DOC 1991a.

TABLE D.3–69.—*Changes in County and City Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2010*

| Jurisdiction | No Actio ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Carson County | 1,634,445 | 1,684,491 | 3.06 | 1,683,812 | 3.02 | 1,680,784 | 2.84 | 1,673,297 | 2.38 | 1,673,297 | 2.38 |
| Potter County | 18,086,368 | 18,472,081 | 2.13 | 18,466,823 | 2.10 | 18,445,746 | 1.99 | 18,391,652 | 1.69 | 18,391,652 | 1.69 |
| Amarillo | 65,293,540 | 66,466,932 | 1.80 | 66,451,082 | 1.77 | 66,387,305 | 1.68 | 66,224,138 | 1.43 | 66,224,138 | 1.43 |
| Randall County | 9,952,042 | 10,160,720 | 2.10 | 10,157,964 | 2.07 | 10,147,038 | 1.96 | 10,119,071 | 1.68 | 10,119,071 | 1.68 |
| **Total ROI County and City Revenues** | 94,966,395 | 96,784,224 | 1.91 | 96,759,680 | 1.89 | 96,660,872 | 1.78 | 96,408,158 | 1.52 | 96,408,158 | 1.52 |
| **Expenditures** | | | | | | | | | | | |
| Carson County | 2,363,542 | 2,428,025 | 2.73 | 2,427,075 | 2.69 | 2,422,955 | 2.51 | 2,412,815 | 2.08 | 2,412,815 | 2.08 |
| Potter County | 19,205,843 | 19,501,413 | 1.54 | 19,496,779 | 1.51 | 19,478,401 | 1.42 | 19,431,258 | 1.17 | 19,431,258 | 1.17 |
| Amarillo | 57,220,243 | 58,037,717 | 1.43 | 58,024,965 | 1.41 | 57,973,958 | 1.32 | 57,843,741 | 1.09 | 57,843,741 | 1.09 |
| Randall County | 9,454,965 | 9,570,907 | 1.23 | 9,569,096 | 1.21 | 9,561,852 | 1.13 | 9,543,381 | 0.94 | 9,543,381 | 0.94 |
| **Total ROI County and City Expenditures** | 88,244,593 | 89,538,062 | 1.47 | 89,517,915 | 1.44 | 89,437,166 | 1.35 | 89,231,195 | 1.12 | 89,231,195 | 1.12 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; PX City 1992a; PX County 1992a; PX DOC 1991a.

**TABLE D.3–70.—*Changes in School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2005 (2003 for Phased APT)***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Amarillo | 105,624,268 | 109,330,030 | 3.51 | 108,943,086 | 3.14 | 113,487,671 | 7.44 | 107,254,233 | 1.54 | 106,018,831 | 0.77 |
| Canyon | 20,628,469 | 21,201,003 | 2.78 | 21,142,370 | 2.49 | 21,845,966 | 5.90 | 20,880,246 | 1.22 | 20,673,306 | 0.62 |
| Groom | 1,187,445 | 1,258,265 | 5.96 | 1,250,894 | 5.34 | 1,337,598 | 12.65 | 1,218,599 | 2.62 | 1,201,047 | 1.31 |
| Panhandle | 4,172,331 | 4,421,172 | 5.96 | 4,395,271 | 5.34 | 4,699,924 | 12.65 | 4,281,796 | 2.62 | 4,220,126 | 1.31 |
| White Deer | 2,780,218 | 2,948,038 | 6.04 | 2,925,662 | 5.23 | 3,132,640 | 12.68 | 2,852,940 | 2.62 | 2,813,782 | 1.41 |
| **Total ROI School District Revenues** | 134,392,731 | 139,158,509 | 3.55 | 138,657,282 | 3.17 | 144,503,799 | 7.52 | 136,487,814 | 1.56 | 134,927,093 | 0.78 |
| **Expenditures** | | | | | | | | | | | |
| Amarillo | 98,658,883 | 101,433,919 | 2.81 | 101,144,158 | 2.52 | 104,547,340 | 5.97 | 99,879,472 | 1.24 | 98,927,932 | 0.62 |
| Canyon | 20,399,581 | 20,898,577 | 2.45 | 20,847,475 | 2.20 | 21,460,699 | 5.20 | 20,619,019 | 1.08 | 20,437,262 | 0.55 |
| Groom | 1,146,607 | 1,214,992 | 5.96 | 1,207,874 | 5.34 | 1,291,596 | 12.65 | 1,176,690 | 2.62 | 1,159,742 | 1.31 |
| Panhandle | 3,832,845 | 4,061,439 | 5.96 | 4,037,645 | 5.34 | 4,317,510 | 12.65 | 3,933,404 | 2.62 | 3,876,751 | 1.31 |
| White Deer | 2,644,040 | 2,803,640 | 6.04 | 2,782,360 | 5.23 | 2,979,200 | 12.68 | 2,713,200 | 2.62 | 2,675,960 | 1.41 |
| **Total ROI School District Expenditures** | 126,681,957 | 130,412,567 | 2.94 | 130,019,511 | 2.63 | 134,596,345 | 6.25 | 128,321,784 | 1.29 | 127,077,647 | 0.65 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX DOC 1991a; PX School 1992a.

TABLE D.3–71.—*Changes in School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling for Pantex Plant Region-of-Influence, 2010*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Amarillo | 106,675,281 | 108,539,011 | 1.75 | 108,509,788 | 1.72 | 108,393,906 | 1.61 | 108,096,644 | 1.33 | 108,096,644 | 1.33 |
| Canyon | 20,835,409 | 21,121,676 | 1.37 | 21,118,227 | 1.36 | 21,100,982 | 1.27 | 21,052,696 | 1.04 | 21,052,696 | 1.04 |
| Groom | 1,192,185 | 1,227,901 | 3.00 | 1,227,375 | 2.95 | 1,225,093 | 2.76 | 1,219,476 | 2.29 | 1,219,476 | 2.29 |
| Panhandle | 4,188,987 | 4,314,482 | 3.00 | 4,312,632 | 2.95 | 4,304,615 | 2.76 | 4,284,880 | 2.29 | 4,284,880 | 2.29 |
| White Deer | 2,791,406 | 2,875,316 | 3.01 | 2,875,316 | 3.01 | 2,869,722 | 2.81 | 2,852,940 | 2.20 | 2,852,940 | 2.20 |
| **Total ROI School District Revenues** | 135,683,269 | 138,078,386 | 1.77 | 138,043,338 | 1.74 | 137,894,318 | 1.63 | 137,506,637 | 1.34 | 137,506,637 | 1.34 |
| **Expenditures** | | | | | | | | | | | |
| Amarillo | 99,442,090 | 100,837,732 | 1.40 | 100,815,849 | 1.38 | 100,729,071 | 1.29 | 100,506,468 | 1.07 | 100,506,468 | 1.07 |
| Canyon | 20,579,729 | 20,829,227 | 1.21 | 20,826,221 | 1.20 | 20,811,191 | 1.12 | 20,769,107 | 0.92 | 20,769,107 | 0.92 |
| Groom | 1,151,185 | 1,185,672 | 3.00 | 1,185,164 | 2.95 | 1,182,960 | 2.76 | 1,177,537 | 2.29 | 1,177,537 | 2.29 |
| Panhandle | 3,848,146 | 3,963,430 | 3.00 | 3,961,730 | 2.95 | 3,954,365 | 2.76 | 3,936,236 | 2.29 | 3,936,236 | 2.29 |
| White Deer | 2,654,680 | 2,734,480 | 3.01 | 2,734,480 | 3.01 | 2,729,160 | 2.81 | 2,713,200 | 2.20 | 2,713,200 | 2.20 |
| **Total ROI School District Expenditures** | 127,675,830 | 129,550,540 | 1.47 | 129,523,443 | 1.45 | 129,406,748 | 1.36 | 129,102,549 | 1.12 | 129,102,549 | 1.12 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX DOC 1991a; PX School 1992a.

**TABLE D.3–72.—*Distribution of Employees by Place of Residence for Savannah River Site, 1991***

| County/City | Number of Employees | Total Site Employment (percent) |
|---|---|---|
| Aiken County | 9,978 | 51.9 |
| Aiken | 4,928 | 25.7 |
| North Augusta | 2,666 | 13.9 |
| Barnwell County | 1,401 | 7.3 |
| Columbia County | 2,036 | 10.6 |
| Richmond County | 3,358 | 17.5 |
| Augusta | 2,780 | 14.5 |
| **Total ROI (County)** | 16,773 | 87.3 |

Source: SRS 1991a:3.

**TABLE D.3–73.—*Employment and Local Economy Statistics for Savannah River Site Economic Study Area, 1970-2020***

| Economic Study Area | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Civilian labor force | 276,846 | 397,236 | 514,763 | 588,416 | 603,918 | 593,201 |
| Total employment | 263,975 | 369,004 | 489,855 | 559,944 | 574,696 | 564,498 |
| Unemployment rate (percent) | 4.6 | 7.1 | 4.8 | 4.8 | 4.8 | 4.8 |
| Personal income (thousand dollars) | 2,161,380 | 6,713,182 | 15,843,875 | 22,031,409 | 23,674,107 | 26,221,085 |
| Per capita income (dollars per person) | 2,873 | 7,210 | 15,012 | 19,049 | 19,978 | 21,335 |

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; SR ESC 1991a.

**TABLE D.3–74.—*Changes in Total Employment, Unemployment Rate, and Per Capita Income During Peak Construction (2005 (2003 Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling Upgrade and Phaseout for Savannah River Site Economic Study Area***

| Economic Study Area | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) | Tritium Recycle Phaseout | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | | | |
| Total employment | 559,944 | 567,143 | 1.29 | 566,807 | 1.23 | 570,739 | 1.93 | 564,179 | 0.76 | 556,352 | 0.40 | | |
| Unemployment rate (percent) | 4.8 | 3.9 | NA | 4.0 | NA | 3.9 | NA | 4.2 | NA | 4.5 | NA | NA | NA |
| Per capita income (dollars per person) | 19,049 | 19,222 | 0.91 | 19,215 | 0.87 | 19,218 | 0.89 | 19,163 | 0.60 | 18,753 | 0.34 | | |
| **Operation** | | | | | | | | | | | | | |
| Total employment | 574,696 | 577,079 | 0.41 | 577,028 | 0.41 | 576,823 | 0.37 | 576,295 | 0.28 | 576,295 | 0.28 | 573,889 | -0.14 |
| Unemployment rate (percent) | 4.8 | 4.5 | NA | 4.6 | NA | 4.6 | NA | 4.6 | NA | 4.6 | NA | 4.9 | NA |
| Per capita income (dollars per person) | 19,978 | 20,033 | 0.27 | 20,032 | 0.27 | 20,027 | 0.24 | 20,015 | 0.18 | 20,015 | 0.18 | 19,960 | -0.09 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOC 1990a; DOC 1990b; DOC 1991a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR ESC 1991a; SR DOE 1995a.

**TABLE D.3–75.—*Population for Savannah River Site Region-of-Influence, 1970-2020***

| Region-of-Influence | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Aiken County | 91,023 | 105,625 | 120,940 | 131,773 | 134,898 | 139,620 |
| Aiken | 13,436 | 14,978 | 19,872 | 21,652 | 22,166 | 22,941 |
| North Augusta | 12,883 | 13,593 | 15,351 | 16,726 | 17,123 | 17,722 |
| Barnwell County | 17,176 | 19,868 | 20,293 | 22,520 | 23,054 | 23,861 |
| Columbia County | 22,327 | 40,118 | 66,031 | 70,494 | 72,612 | 75,589 |
| Richmond County | 162,437 | 181,629 | 189,719 | 217,776 | 224,320 | 233,517 |
| Augusta | 59,864 | 47,532 | 44,639 | 51,241 | 52,780 | 54,944 |
| **Total ROI (County)** | 292,963 | 347,240 | 396,983 | 442,563 | 454,884 | 472,587 |

Source: Census 1973a; Census 1977a; Census 1983a; SR Census 1991a; SR Census 1991b.

TABLE D.3–76.—*Changes in Population During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling Upgrade and Phaseout for Savannah River Site Region-of-Influence*

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) | Tritium Recycle Phaseout | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | | | |
| Aiken County | 131,773 | 133,873 | 1.59 | 133,726 | 1.48 | 138,192 | 4.87 | 132,578 | 0.61 | 130,855 | 0.24 | | |
| Aiken | 21,652 | 22,692 | 4.80 | 22,619 | 4.47 | 24,831 | 14.68 | 22,051 | 1.84 | 21,604 | 0.72 | | |
| North Augusta | 16,726 | 17,288 | 3.36 | 17,249 | 3.13 | 18,445 | 10.28 | 16,941 | 1.29 | 16,653 | 0.50 | | |
| Barnwell County | 22,520 | 22,815 | 1.31 | 22,795 | 1.22 | 23,423 | 4.01 | 22,633 | 0.50 | 22,354 | 0.20 | NA | NA |
| Columbia County | 70,494 | 70,923 | 0.61 | 70,893 | 0.57 | 71,805 | 1.86 | 70,659 | 0.23 | 69,728 | 0.09 | | |
| Richmond County | 217,776 | 218,484 | 0.33 | 218,435 | 0.30 | 219,941 | 0.99 | 218,047 | 0.12 | 215,317 | 0.05 | | |
| Augusta | 51,241 | 51,827 | 1.14 | 51,786 | 1.06 | 53,034 | 3.50 | 51,465 | 0.44 | 50,725 | 0.17 | | |
| **Total ROI Construction** | 442,563 | 446,095 | 0.80 | 445,849 | 0.74 | 453,361 | 2.44 | 443,917 | 0.31 | 438,254 | 0.12 | | |
| **Operation** | | | | | | | | | | | | | |
| Aiken County | 134,898 | 135,625 | 0.54 | 135,610 | 0.53 | 135,547 | 0.48 | 135,386 | 0.36 | 135,386 | 0.36 | 134,652 | -0.18 |
| Aiken | 22,166 | 22,526 | 1.63 | 22,518 | 1.59 | 22,487 | 1.45 | 22,408 | 1.09 | 22,408 | 1.09 | 22,044 | -0.55 |
| North Augusta | 17,123 | 17,318 | 1.14 | 17,314 | 1.12 | 17,297 | 1.02 | 17,254 | 0.77 | 17,254 | 0.77 | 17,057 | -0.38 |
| Barnwell County | 23,054 | 23,156 | 0.44 | 23,154 | 0.44 | 23,145 | 0.40 | 23,123 | 0.30 | 23,123 | 0.30 | 23,019 | -0.15 |
| Columbia County | 72,612 | 72,760 | 0.20 | 72,757 | 0.20 | 72,745 | 0.18 | 72,712 | 0.14 | 72,712 | 0.14 | 72,562 | -0.07 |
| Richmond County | 224,320 | 224,565 | 0.11 | 224,560 | 0.11 | 224,539 | 0.10 | 224,485 | 0.07 | 224,485 | 0.07 | 224,237 | -0.04 |
| Augusta | 52,780 | 52,983 | 0.38 | 52,979 | 0.38 | 52,961 | 0.34 | 52,916 | 0.26 | 52,916 | 0.26 | 52,711 | -0.13 |
| **Total ROI Operation** | 454,884 | 456,106 | 0.27 | 456,081 | 0.26 | 455,976 | 0.24 | 455,706 | 0.18 | 455,706 | 0.18 | 454,470 | -0.09 |

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR Census 1991a; SR Census 1991b; SR DOE 1995a.

**TABLE D.3–77.—*Total Housing Units for Savannah River Site Region-of-Influence, 1970-2020***

| Region-of-Influence | 1970 | 1980 | 1990 | 2005 | 2010 | 2020 |
|---|---|---|---|---|---|---|
| Aiken County | 29,400 | 39,791 | 49,266 | 53,679 | 54,942 | 56,875 |
| Aiken | 4,759 | 6,173 | 8,543 | 9,308 | 9,529 | 9,862 |
| North Augusta | 4,342 | 5,470 | 6,818 | 7,429 | 7,605 | 7,868 |
| Barnwell County | 5,384 | 7,282 | 7,854 | 8,716 | 8,922 | 9,235 |
| Columbia County | 6,740 | 14,099 | 23,745 | 25,350 | 26,112 | 27,182 |
| Richmond County | 47,751 | 64,846 | 77,288 | 88,718 | 91,384 | 95,130 |
| Augusta | 21,159 | 20,825 | 21,588 | 24,781 | 25,525 | 26,572 |
| **Total ROI (County)** | 89,275 | 126,018 | 158,153 | 176,463 | 181,370 | 188,423 |

Source: Census 1972a; Census 1973a; Census 1977a; Census 1982a; Census 1983a; SR Census 1991a; SR Census 1991b.

**TABLE D.3–78.—*Changes in Housing Demands During Peak Construction (2005 (2003 for Phased APT)) and Full Operation (2010) from Tritium Supply Technologies and Recycling Upgrade and Phaseout for Savannah River Site Region-of-Influence***

| Region-of-Influence | No Action | HWR | Change (percent) | MHTGR | Change (percent) | ALWR | Change (percent) | Full APT | Change (percent) | Phased APT | Change (percent) | Tritium Recycle Phaseout | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Construction** | | | | | | | | | | | | | |
| Aiken County | 53,679 | 54,477 | 1.49 | 54,422 | 1.38 | 56,120 | 4.55 | 53,985 | 0.57 | 53,297 | 0.22 | | |
| Aiken | 9,308 | 9,704 | 4.25 | 9,676 | 3.95 | 10,517 | 12.99 | 9,460 | 1.63 | 9,280 | 0.64 | | |
| North Augusta | 7,429 | 7,642 | 2.88 | 7,628 | 2.68 | 8,082 | 8.80 | 7,510 | 1.10 | 7,391 | 0.43 | | |
| Barnwell County | 8,716 | 8,828 | 1.29 | 8,820 | 1.20 | 9,059 | 3.94 | 8,759 | 0.49 | 8,651 | 0.20 | NA | NA |
| Columbia County | 25,350 | 25,513 | 0.64 | 25,502 | 0.60 | 25,848 | 1.97 | 25,413 | 0.25 | 25,076 | 0.10 | | |
| Richmond County | 88,718 | 88,987 | 0.30 | 88,968 | 0.28 | 89,541 | 0.93 | 88,821 | 0.12 | 87,713 | 0.05 | | |
| Augusta | 24,781 | 25,004 | 0.90 | 24,988 | 0.84 | 25,463 | 2.75 | 24,866 | 0.34 | 24,522 | 0.14 | | |
| **Total ROI Construction** | 176,463 | 177,806 | 0.76 | 177,712 | 0.71 | 180,568 | 2.33 | 176,977 | 0.29 | 174,737 | 0.11 | | |
| **Operation** | | | | | | | | | | | | | |
| Aiken County | 54,952 | 55,228 | 0.50 | 55,223 | 0.49 | 55,199 | 0.45 | 55,137 | 0.34 | 55,137 | 0.34 | 54,852 | -0.18 |
| Aiken | 9,529 | 9,666 | 1.44 | 9,663 | 1.41 | 9,651 | 1.28 | 9,621 | 0.97 | 9,621 | 0.97 | 9,477 | -0.55 |
| North Augusta | 7,605 | 7,679 | 0.98 | 7,678 | 0.96 | 7,671 | 0.87 | 7,655 | 0.66 | 7,655 | 0.66 | 7,576 | -0.38 |
| Barnwell County | 8,922 | 8,961 | 0.44 | 8,961 | 0.43 | 8,957 | 0.39 | 8,949 | 0.30 | 8,949 | 0.30 | 8,909 | -0.15 |
| Columbia County | 26,112 | 26,168 | 0.22 | 26,167 | 0.21 | 26,162 | 0.19 | 26,150 | 0.15 | 26,150 | 0.15 | 26,094 | -0.07 |
| Richmond County | 91,384 | 91,477 | 0.10 | 91,475 | 0.10 | 91,467 | 0.09 | 91,447 | 0.07 | 91,447 | 0.07 | 91,350 | -0.04 |
| Augusta | 25,525 | 25,602 | 0.30 | 25,601 | 0.30 | 25,594 | 0.27 | 25,577 | 0.20 | 25,577 | 0.20 | 25,492 | -0.13 |
| **Total ROI Operation** | 181,370 | 181,835 | 0.26 | 181,825 | 0.25 | 181,785 | 0.23 | 181,682 | 0.17 | 181,682 | 0.17 | 181,204 | -0.09 |

Note: NA - not applicable.

Source: Census 1973a; Census 1977a; Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR Census 1991a; SR Census 1991b; SR DOE 1995a.

**TABLE D.3–79.—*County and City Revenues and Expenditures for Savannah River Site Region-of-Influence, 1992***

| Revenues and Expenditures | Aiken County[a] | Aiken | North Augusta | Barnwell County | Columbia County | Richmond County | August |
|---|---|---|---|---|---|---|---|
| Property tax (percent) | 59 | 43 | 50 | 25 | 74 | 74 | 58 |
| State shared and intergovernmental (percent) | 23 | 8 | 10 | 73 | 7 | 0 | 21 |
| Permits, fees, fines, and investment interest (percent) | 17 | 49 | 36 | 0 | 10 | 15 | 14 |
| Other (percent) | 1 | 1 | 4 | 3 | 9 | 11 | 7 |
| **Total Revenues (dollars)** | 26,055,374 | 11,504,145 | 5,679,679 | 7,390,553 | 25,758,888 | 87,230,497 | 33,282,930 |
| General Government (percent) | 22 | 8 | 10 | 37 | 12 | 28 | 23 |
| Public safety, health, and welfare (percent) | 26 | 31 | 26 | 38 | 36 | 35 | 31 |
| Public works, fees, fines, and investment interest (perfect) | 20 | 30 | 18 | 17 | 17 | 11 | 19 |
| Debt service (percent) | 16 | 3 | 4 | 0 | 1 | 3 | 5 |
| Capital project (percent) | 11 | 12 | 42 | 0 | 10 | 23 | 22 |
| Other (percent) | 5 | 16 | 0 | 8 | 24 | 0 | 0 |
| **Total Expenditures (dollars)** | 30,782,399 | 11,639,638 | 9,029,817 | 5,065,164 | 23,474,763 | 87,079,716 | 39,603,007 |
| **End-of-Year Fund Balance (dollars)** | 464,670 | 8,327,903 | 2,714,492 | 5,472,719 | 5,060,786 | 38,041,195 | 8,024,752 |

[a] Estimated from 1989-1991 financial audits and 1992 fiscal budgets.
Source: SR City 1992a; SR County 1992a.

TABLE D.3–80.—*School District Revenues and Expenditures for Savannah River Site Region-of-Influence, 1992*

| Revenues and Expenditures | School District | | | | | |
|---|---|---|---|---|---|---|
| | Aiken County | Barwell County #19 | Barwell County #29 | Barnwell County #45[a] | Columbia County | Richmond County |
| Local sources (percent) | 39 | 19 | 21 | 25 | 33 | 33 |
| Intermediate sources (percent) | 0 | 0 | 4 | 1 | 0 | 0 |
| State sources (percent) | 55 | 64 | 67 | 58 | 64 | 58 |
| Federal source (percent) | 6 | 17 | 8 | 16 | 3 | 9 |
| **Total Revenues (dollars)** | 97,408,101 | 5,830,056 | 8,105,837 | 10,928,093 | 51,511,933 | 144,200,546 |
| Total expenditures per pupil (dollars) | 4,409 | 4,016 | 2,569 | 4,700 | 4,322 | 4,608 |
| Total instructions (percent) | 51 | 59 | 19 | 52 | 54 | 55 |
| Support services (percent) | 29 | 38 | 4 | 23 | 26 | 31 |
| Food, community, and other services (percent) | 1 | 1 | 67 | 20 | 4 | 5 |
| Capital assets (percent) | 7 | 0 | 8 | 0 | 12 | 7 |
| Debt service (percent) | 11 | 2 | 0 | 6 | 4 | 2 |
| **Total Expenditures (dollars)** | 107,031,526 | 5,187,885 | 8,105,837 | 12,075,596 | 57,292,094 | 149,113,505 |
| **End-of-Year Fund Balance (dollars)** | 14,249,675 | 710,596 | 789,567 | 72,937 | 21,629,630 | 18,290,485 |

[a] Estimated from 1989-1991 financial audits and 1992 fiscal budgets.

Source: SR School 1992a.

TABLE D.3–81.—*Changes in County and City Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Aiken County | 27,054,664 | 27,375,525 | 1.19 | 27,353,256 | 1.10 | 28,011,815 | 3.54 | 27,180,673 | 0.47 | 26,920,126 | 0.18 |
| Aiken | 12,212,286 | 12,445,274 | 1.91 | 12,430,629 | 1.79 | 12,768,647 | 4.56 | 12,327,813 | 0.95 | 12,165,370 | 0.39 |
| North Augusta | 6,026,503 | 6,144,024 | 1.95 | 6,136,724 | 1.83 | 6,299,204 | 4.53 | 6,086,150 | 0.99 | 6,005,046 | 0.41 |
| Barnwell County | 4,380,812 | 4,409,653 | 0.66 | 4,407,700 | 0.61 | 4,468,419 | 2.00 | 4,391,886 | 0.25 | 4,362,175 | 0.09 |
| Columbia County | 24,730,949 | 24,854,572 | 0.50 | 24,845,926 | 0.46 | 25,106,458 | 1.52 | 24,778,487 | 0.19 | 24,506,892 | 0.07 |
| Richmond County | 94,851,377 | 95,226,892 | 0.40 | 95,203,372 | 0.37 | 95,801,958 | 1.00 | 95,023,283 | 0.18 | 93,939,200 | 0.07 |
| Augusta | 36,080,288 | 36,194,320 | 0.32 | 36,187,167 | 0.30 | 36,369,793 | 0.80 | 36,132,365 | 0.14 | 35,808,425 | 0.06 |
| **Total ROI Revenues** | 205,336,878 | 206,650,259 | 0.64 | 206,564,774 | 0.60 | 208,826,293 | 1.70 | 205,920,657 | 0.28 | 203,707,234 | 0.11 |
| **Expenditures** | | | | | | | | | | | |
| Aiken County | 31,113,945 | 31,209,753 | 0.31 | 31,203,047 | 0.29 | 31,404,916 | 0.94 | 31,150,675 | 0.12 | 31,091,270 | 0.04 |
| Aiken | 12,146,828 | 12,248,029 | 0.83 | 12,240,945 | 0.77 | 12,454,175 | 2.53 | 12,185,626 | 0.32 | 12,090,301 | 0.12 |
| North Augusta | 7,640,305 | 7,706,586 | 0.87 | 7,701,947 | 0.81 | 7,841,600 | 2.63 | 7,665,716 | 0.33 | 7,582,494 | 0.12 |
| Barnwell County | 4,824,019 | 4,840,531 | 0.34 | 4,839,413 | 0.32 | 4,874,176 | 1.04 | 4,830,359 | 0.13 | 4,803,574 | 0.05 |
| Columbia County | 21,999,236 | 22,113,180 | 0.52 | 22,105,211 | 0.48 | 22,345,344 | 1.57 | 22,043,053 | 0.20 | 21,786,352 | 0.07 |
| Richmond County | 93,276,562 | 93,464,763 | 0.20 | 93,451,733 | 0.19 | 93,848,485 | 0.61 | 93,348,556 | 0.08 | 92,630,935 | 0.03 |
| Augusta | 40,061,036 | 40,144,914 | 0.21 | 40,139,107 | 0.19 | 40,315,933 | 0.64 | 40,093,123 | 0.08 | 39,731,260 | 0.03 |
| **Total ROI Expenditures** | 211,061,931 | 211,727,756 | 0.32 | 211,681,402 | 0.29 | 213,084,629 | 0.96 | 211,317,107 | 0.12 | 209,716,187 | 0.04 |

Source: Census 1973a; Census 1977a, Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR City 1992a; SR County 1992a; SR ESC 1991a; SR DOE 1995a.

TABLE D.3–82.—*Changes to County and City Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade and Phaseout for Savannah River Site Region-of-Influence, 2010*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | APT Full ($) | Change (percent) | APT Phased ($) | Change (percent) | Tritium Recycle Phaseout ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | | | |
| Aiken County | 27,519,712 | 27,630,704 | 0.40 | 27,628,660 | 0.40 | 27,618,790 | 0.36 | 27,594,198 | 0.27 | 27,594,198 | 0.27 | 27,481,977 | -0.14 |
| Aiken | 12,456,386 | 12,536,766 | 0.65 | 12,537,271 | 0.65 | 12,528,139 | 0.58 | 12,510,332 | 0.43 | 12,510,332 | 0.43 | 12,428,209 | -0.23 |
| North Augusta | 6,143,551 | 6,184,083 | 0.66 | 6,184,451 | 0.67 | 6,179,733 | 0.59 | 6,170,753 | 0.44 | 6,170,753 | 0.44 | 6,129,293 | -0.23 |
| Barnwell County | 4,431,083 | 4,441,070 | 0.23 | 4,440,875 | 0.22 | 4,439,996 | 0.20 | 4,437,848 | 0.15 | 4,437,848 | 0.15 | 4,427,696 | -0.08 |
| Columbia County | 25,338,535 | 25,381,104 | 0.17 | 25,380,239 | 0.16 | 25,376,781 | 0.15 | 25,367,270 | 0.11 | 25,367,270 | 0.11 | 25,324,041 | -0.06 |
| Richmond County | 97,287,668 | 97,413,903 | 0.13 | 97,412,306 | 0.13 | 97,400,458 | 0.12 | 97,372,586 | 0.09 | 97,372,586 | 0.09 | 97,242,990 | -0.05 |
| Augusta | 36,824,758 | 36,863,108 | 0.10 | 36,862,619 | 0.10 | 36,859,024 | 0.09 | 36,850,557 | 0.07 | 36,850,557 | 0.07 | 36,811,193 | -0.04 |
| **Total ROI Revenues** | 210,001,693 | 210,450,738 | 0.21 | 210,446,421 | 0.21 | 210,402,921 | 0.19 | 210,303,545 | 0.14 | 210,303,545 | 0.14 | 209,845,399 | -0.07 |
| **Expenditures** | | | | | | | | | | | | | |
| Aiken County | 31,271,127 | 31,304,277 | 0.11 | 31,303,593 | 0.10 | 31,300,719 | 0.09 | 31,293,374 | 0.07 | 31,293,374 | 0.07 | 31,259,889 | -0.04 |
| Aiken | 12,295,264 | 12,330,279 | 0.28 | 12,329,557 | 0.28 | 12,326,521 | 0.25 | 12,318,763 | 0.19 | 12,318,763 | 0.19 | 12,283,393 | -0.10 |
| North Augusta | 7,733,322 | 7,756,255 | 0.30 | 7,755,782 | 0.29 | 7,753,793 | 0.26 | 7,748,712 | 0.20 | 7,748,712 | 0.20 | 7,725,547 | -0.10 |
| Barnwell County | 4,849,991 | 4,855,709 | 0.12 | 4,855,597 | 0.12 | 4,855,094 | 0.11 | 4,853,864 | 0.08 | 4,853,864 | 0.08 | 4,848,052 | -0.04 |
| Columbia County | 22,551,729 | 22,590,965 | 0.17 | 22,590,168 | 0.17 | 22,586,981 | 0.16 | 22,578,215 | 0.12 | 22,578,215 | 0.12 | 22,538,370 | -0.06 |
| Richmond County | 95,025,304 | 95,090,422 | 0.07 | 95,089,092 | 0.07 | 95,083,508 | 0.06 | 95,069,148 | 0.05 | 95,069,148 | 0.05 | 95,003,200 | -0.02 |
| Augusta | 40,834,768 | 40,863,790 | 0.07 | 40,863,197 | 0.07 | 40,860,708 | 0.06 | 40,854,308 | 0.05 | 40,854,308 | 0.05 | 40,824,916 | -0.02 |
| **Total ROI Expenditures** | 214,561,504 | 214,791,696 | 0.11 | 214,786,985 | 0.11 | 214,767,323 | 0.10 | 214,716,384 | 0.07 | 214,716,384 | 0.07 | 214,483,366 | -0.04 |

Source: Census 1973a; Census 1977a, Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR City 1992a; SR County 1992a; SR ESC 1991a; SR DOE 1995a.

TABLE D.3–83.—*Changes in School District Total Revenues and Expenditures Over/Under No Action During Peak Construction from Tritium Supply Technologies and Recycling Upgrade for Savannah River Site Region-of-Influence, 2005 (2003 for Phased APT)*

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | |
| Aiken County | 104,818,039 | 106,488,579 | 1.59 | 106,371,648 | 1.48 | 109,891,491 | 4.84 | 105,458,478 | 0.61 | 104,072,375 | 0.22 |
| Barnwell County #19 | 5,534,346 | 5,587,394 | 0.96 | 5,583,803 | 0.89 | 5,695,485 | 2.91 | 5,554,715 | 0.37 | 5,501,355 | 0.14 |
| Barnwell County #29 | 4,481,168 | 4,506,901 | 0.57 | 4,505,159 | 0.54 | 4,559,337 | 1.74 | 4,491,049 | 0.22 | 4,464,185 | 0.08 |
| Barnwell County #45 | 11,931,968 | 12,087,450 | 1.30 | 12,076,924 | 1.21 | 12,404,264 | 3.96 | 11,991,669 | 0.50 | 11,844,197 | 0.19 |
| Columbia County | 54,178,029 | 54,401,160 | 0.41 | 54,385,555 | 0.38 | 54,855,799 | 1.25 | 54,263,833 | 0.16 | 53,770,175 | 0.06 |
| Richmond County | 156,300,012 | 156,651,709 | 0.23 | 156,627,359 | 0.21 | 157,368,781 | 0.68 | 156,434,550 | 0.09 | 155,080,623 | 0.03 |
| **Total School District Revenues** | 337,243,562 | 339,723,193 | 0.74 | 339,550,449 | 0.68 | 344,775,157 | 2.23 | 338,194,292 | 0.28 | 334,732,910 | 0.10 |
| **Expenditures** | | | | | | | | | | | |
| Aiken County | 110,683,758 | 112,163,651 | 1.34 | 112,060,065 | 1.24 | 115,178,215 | 4.06 | 111,251,108 | 0.51 | 110,015,400 | 0.19 |
| Barnwell County #19 | 5,634,645 | 5,706,512 | 1.28 | 5,701,647 | 1.19 | 5,852,950 | 3.87 | 5,662,240 | 0.49 | 5,593,715 | 0.18 |
| Barnwell County #29 | 4,524,924 | 4,582,917 | 1.28 | 4,578,992 | 1.19 | 4,701,088 | 3.89 | 4,547,192 | 0.49 | 4,491,662 | 0.18 |
| Barnwell County #45 | 12,819,287 | 12,948,398 | 1.01 | 12,939,658 | 0.94 | 13,211,479 | 3.06 | 12,868,862 | 0.39 | 12,747,228 | 0.15 |
| Columbia County | 60,449,018 | 60,758,215 | 0.51 | 60,736,590 | 0.48 | 61,388,213 | 1.55 | 60,567,918 | 0.20 | 59,870,470 | 0.07 |
| Richmond County | 156,897,416 | 157,064,087 | 0.11 | 157,052,548 | 0.10 | 157,403,911 | 0.32 | 156,961,175 | 0.04 | 156,301,749 | 0.01 |
| **Total School District Expenditures** | 351,009,048 | 353,223,781 | 0.63 | 353,069,499 | 0.59 | 357,735,857 | 1.92 | 351,858,493 | 0.24 | 349,020,225 | 0.09 |

Source: Census 1973a; Census 1977a, Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR ESC 1991a; SR DOE 1995a; SR School 1992a.

**TABLE D.3–84.—*Changes in School District Total Revenues and Expenditures Over/Under No Action at Full Operation from Tritium Supply Technologies and Recycling Upgrade and Phaseout for Savannah River Site Region-of-Influence, 2010***

| Jurisdiction | No Action ($) | HWR ($) | Change (percent) | MHTGR ($) | Change (percent) | ALWR ($) | Change (percent) | Full APT ($) | Change (percent) | Phased APT ($) | Change (percent) | Tritium Recycle Phaseout ($) | Change (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revenues** | | | | | | | | | | | | | |
| Aiken County | 107,304,188 | 107,882,198 | 0.54 | 107,870,266 | 0.53 | 107,820,153 | 0.48 | 107,692,086 | 0.36 | 107,692,086 | 0.36 | 107,108,230 | -0.18 |
| Barnwell County #19 | 5,627,386 | 5,645,755 | 0.33 | 5,645,396 | 0.32 | 5,643,780 | 0.29 | 5,639,830 | 0.22 | 5,639,830 | 0.22 | 5,621,156 | -0.11 |
| Barnwell County #29 | 4,526,886 | 4,535,797 | 0.20 | 4,535,622 | 0.19 | 4,534,839 | 0.18 | 4,532,922 | 0.13 | 4,532,922 | 0.13 | 4,523,864 | -0.07 |
| Barnwell County #45 | 12,213,030 | 12,266,871 | 0.44 | 12,265,818 | 0.43 | 12,261,082 | 0.39 | 12,249,504 | 0.30 | 12,249,504 | 0.30 | 12,194,772 | -0.15 |
| Columbia County | 55,269,463 | 55,346,297 | 0.14 | 55,344,736 | 0.14 | 55,338,494 | 0.12 | 55,321,328 | 0.09 | 55,321,328 | 0.09 | 55,243,301 | -0.05 |
| Richmond County | 159,553,179 | 159,674,867 | 0.08 | 159,672,382 | 0.07 | 159,661,947 | 0.07 | 159,635,112 | 0.05 | 159,635,112 | 0.05 | 159,511,873 | -0.03 |
| **Total School District Revenues** | 344,494,131 | 345,351,784 | 0.25 | 345,334,221 | 0.24 | 345,260,294 | 0.22 | 345,070,783 | 0.17 | 345,070,783 | 0.17 | 344,203,196 | -0.08 |
| **Expenditures** | | | | | | | | | | | | | |
| Aiken County | 112,875,249 | 113,387,295 | 0.45 | 113,376,725 | 0.44 | 113,332,331 | 0.40 | 113,218,880 | 0.30 | 113,218,880 | 0.30 | 112,701,654 | -0.15 |
| Barnwell County #19 | 5,764,535 | 5,789,421 | 0.43 | 5,788,935 | 0.42 | 5,786,746 | 0.39 | 5,781,394 | 0.29 | 5,781,394 | 0.29 | 5,756,096 | -0.15 |
| Barnwell County #29 | 4,629,708 | 4,649,790 | 0.43 | 4,649,398 | 0.43 | 4,647,631 | 0.39 | 4,643,313 | 0.29 | 4,643,313 | 0.29 | 4,622,898 | -0.15 |
| Barnwell County #45 | 13,053,960 | 13,098,669 | 0.34 | 13,097,794 | 0.34 | 13,093,861 | 0.31 | 13,084,247 | 0.23 | 13,084,247 | 0.23 | 13,038,798 | -0.12 |
| Columbia County | 61,956,151 | 62,062,621 | 0.17 | 62,060,458 | 0.17 | 62,051,808 | 0.15 | 62,028,021 | 0.12 | 62,028,021 | 0.12 | 61,919,898 | -0.06 |
| Richmond County | 158,434,499 | 158,492,168 | 0.04 | 158,490,990 | 0.04 | 158,486,045 | 0.03 | 158,473,328 | 0.02 | 158,473,328 | 0.02 | 158,414,924 | -0.01 |
| **Total School District Expenditures** | 356,714,103 | 357,479,964 | 0.21 | 357,464,301 | 0.21 | 357,398,423 | 0.19 | 357,229,183 | 0.14 | 357,229,183 | 0.14 | 356,454,268 | -0.07 |

Source: Census 1973a; Census 1977a, Census 1983a; DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a; SR ESC 1991a; SR DOE 1995a; SR School 1992a.

# APPENDIX E

# Appendix E

# APPENDIX E: HUMAN HEALTH

## E.1 INTRODUCTION

Detailed information on the potential impacts to humans from the normal operational releases of radioactivity and hazardous chemicals from the tritium supply technologies and recycling facilities is presented in this appendix. This information is intended to support assessments of normal operation for the tritium supply and recycling facilities described in sections 4.2.3.9, 4.3.3.9, 4.4.3.9, 4.5.3.9, and 4.6.3.9 of this Programmatic Environmental Impact Statement (PEIS). Section E.2 provides information on radiological impacts while section E.3 provides information on hazardous chemical impacts.

## E.2 RADIOLOGICAL IMPACTS TO HUMAN HEALTH

Section E.2 presents supporting information on the potential radiological impacts of normal operation to humans. This section provides the reader with background information on the nature of radiation (section E.2.1), the methodology used to calculate radiological impacts (section E.2.2), radiological releases from tritium supply and recycling facilities (section E.2.3), and radiological impacts from various tritium supply technologies and recycling facilities at each site (sections E.2.4 through E.2.8).

### E.2.1 Background

#### E.2.1.1 *Nature of Radiation and Its Effects on Humans*

**What is Radiation?** Humans are constantly exposed to radiation from the solar system and from the earth's rocks and soil. This radiation contributes to the natural background radiation that has always been around us. But there are also manmade sources of radiation, such as medical and dental X-rays, household smoke detectors, and materials released from nuclear and coal-fired powerplants.

All matter in the universe is composed of atoms, and radiation comes from the activity of these tiny particles. Atoms are made up of even smaller particles (protons, neutrons, electrons). The number and arrangement of these particles distinguishes one atom from another.

Atoms of different types are known as elements. There are over 100 natural and manmade elements. Some of these elements, such as uranium, radium, plutonium, and thorium, share a very important quality: they are unstable. As they change into more stable forms, invisible waves of energy or particles, known as ionizing radiation, are released. Radioactivity is the emitting of this radiation.

Ionizing radiation refers to the fact that this energy force can ionize, or electrically charge atoms by stripping off electrons. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles, and gamma and X-rays) and the total amount of radiation energy absorbed by the body. Alpha particles are the heaviest of these direct types of ionizing radiation, and despite a speed of about 10,000 miles per second, they can travel only a few inches in air. Alpha particles lose their energy almost as soon as they collide with anything. They can easily be stopped by a sheet of paper or the skin's surface.

Beta particles are much lighter than alpha particles. They can travel as much as 100,000 miles per second and can travel in the air for a distance of about 10 feet. Beta particles can pass through a sheet of paper, but may be stopped by a thin sheet of aluminum foil or glass.

Gamma and X-rays, unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light (186,000 miles per second). Gamma radiation is very penetrating and requires a thick wall of concrete, lead, or steel to stop it.

The neutron is another particle which contributes to radiation exposure, both directly and indirectly. The latter is associated with the gamma rays and alpha particles which are emitted following neutron capture in matter. A neutron has about one quarter the weight of an alpha particle and can travel at speeds of up to 24,000 miles per second. Neutrons are more penetrating than beta particles, but less than gamma rays.

The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. For example, a quantity of iodine-131, a material that has a half-life of 8 days, will lose half of its radioactivity in that amount of time. In 8 more days, half of the remaining radioactivity will be lost, and so on. Eventually, the radioactivity will essentially disappear. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to millions of years.

As a radioactive element gives up its radioactivity, it often changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation may take place in several steps and is known as a decay chain. Radium, for example, is a naturally occurring radioactive element with a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays to polonium and through a series of steps to bismuth and ultimately to lead.

**Units of Radiation Measure.** Scientists and engineers use a variety of units to measure radiation. These different units can be used to determine the amount, type and intensity of radiation. Just as heat can be measured in terms of its intensity or its effects using units of calories or degrees, amount of radiation can be measured in curies, rads, or rems.

The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" of a sample of radioactive material. The rate of decay of 1 gram of radium is the basis of this unit of measure. It is equal to $3.7 \times 10^{10}$ disintegrations (decays) per sec.

The total energy absorbed per unit quantity of tissue is referred to as absorbed dose. The rad is the unit of measurement for the physical absorption of radiation. Much like sunlight heats the pavement by giving up an amount of energy to it, radiation gives up rads of energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

A rem is a measurement of the dose from radiation based on its biological effects. The rem is used to measure the effects of radiation on the body, much like degrees Celsius can be used to measure the effects of sunlight heating pavement. Thus, 1 rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other kind of radiation. This standard allows comparison of the biological effects of radionuclides that emit different types of radiation.

An individual may be exposed to ionizing radiation externally from a radioactive source outside the body, and/or internally from ingesting radioactive material. The external dose is different from the internal dose. An external dose is delivered only during the actual time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive source is in the body, although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time. The dose from internal exposure is calculated over 50 years following the initial exposure.

The three types of doses calculated in this PEIS include an external dose, an internal dose, and a combined external and internal dose. Each type of dose is discussed separately below.

*External Dose.* The external dose can arise from several different pathways. All these pathways have in common the fact that the radiation causing the exposure is external to the body. In this PEIS, these pathways include exposure to a cloud of radiation passing overhead of the receptor, standing on ground which is contaminated with radioactivity, swimming in contaminated water, and boating in contaminated water. The appropriate measure of dose is called the effective dose equivalent. It should be noted that if the receptor departs from the source of radiation exposure, his dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year.

*Internal Dose.* The internal dose arises from a radiation source entering the human body through either ingestion of contaminated food and water or inhalation of contaminated air. In this PEIS, pathways for internal exposure include ingestion of crops contaminated either by airborne radiation depositing on the crops or by irrigation of crops using contaminated water sources, ingestion of animal products from animals that ingested contaminated food, ingestion of contaminated water, inhalation of contaminated air, and absorption of contaminated water through the skin during swimming. Unlike external exposures, once the radiation enters the body, it remains there for various periods of time that depend on decay and biological elimination rates. The unit of measure for internal doses is the committed dose equivalent. It is the internal dose that each body organ receives from 1 "year intake" (ingestion plus inhalation). Normally, a 50- or 70-year dose-commitment period is used (i.e., the one-year intake period plus 49 or 69 years). The dose rate increases during the 1 year of intake. The dose rate, after the one year of intake, slowly declines as the radioactivity in the body continues to produce a dose. The integral of the dose rate over the 50 or 70 years gives the committed dose equivalent. In this PEIS, a 50-year, dose-commitment period was used.

The various organs of the body have different susceptibilities to harm from radiation. The quantity that takes these different susceptibilities into account to provide a broad indicator of the risk to the health of an individual from radiation is called the committed effective dose equivalent. It is obtained by multiplying the committed dose equivalent in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals. It is possible that the committed dose equivalent to an organ is larger than the committed effective dose equivalent if that organ has a small weighting factor. The concept of committed effective dose equivalent applies only to internal pathways.

*Combined External and Internal Dose.* For convenience, the sum of the committed effective dose equivalent from internal pathways and the effective dose equivalent from external pathways is also called the committed effective dose equivalent in this PEIS (note that in DOE Order 5400.5, this quantity is called the effective dose equivalent).

The units used in this PEIS for committed dose equivalent, effective dose equivalent, and committed effective dose equivalent to an individual are the rem and mrem (1/1000 of 1 rem). The corresponding unit for the collective dose to a population (the sum of the doses to members of the population, or the product of the number of exposed individuals and their average dose) is the person-rem.

**Sources of Radiation.** The average American receives a total of about 350 mrem per year from all sources of radiation, both natural and manmade. The sources of radiation can be divided into six different categories: cosmic radiation, terrestrial radiation, internal radiation, consumer products, medical diagnosis and therapy, and other sources. Each category is discussed below.

Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the earth's atmosphere. These particles and the secondary particles and photons they create are cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with altitude above sea level. For the sites considered in this PEIS, the cosmic radiation ranged from about 30 to 50 mrem per year. The average annual dose to the people in the United States is about 27 mrem.

External terrestrial radiation is the radiation emitted from the radioactive materials in the earth's rocks and soils. The average annual dose from external terrestrial radiation is about 28 mrem. The external terrestrial radiation for the sites in this PEIS ranged from about 30 to 75 mrem per year.

Internal radiation arises from the human body metabolizing natural radioactive material which has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributor to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon which contribute about 200 mrem per year. The average dose from other internal radionuclides is about 39 mrem per year.

Consumer products also contain sources of ionizing radiation. In some products, like smoke detectors

and airport X-ray machines, the radiation source is essential to the products' operation. In other products, such as television and tobacco, the radiation occurs incidentally to the product function. The average annual dose is about 10 mrem.

Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic X-rays result in an average annual exposure of 39 mrem. Nuclear medical procedures result in an average annual exposure of 14 mrem.

There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities such as uranium mines, mills and fuel processing plants, nuclear power plants and transportation routes has been estimated to be less than 1 mrem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions of radioactive material from Department of Energy (DOE) facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials contributes less than 1 mrem per year to the average dose to an individual. Air travel contributes approximately 1 mrem per year to the average dose.

The collective (or population) dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. This total dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 1 millirem (0.001 rem), the collective dose is 1,000 persons x 0.001 rem = 1.0 person-rem. Alternatively, the same collective dose (1.0 person-rem) results from 500 people each of whom received a dose of 2 millirem (500 persons x 2 millirem = 1 person-rem).

**Limits of Radiation Exposure.** The amount of manmade radiation that the public may be exposed to is limited by Federal regulations. Although most scientists believe that radiation absorbed in small doses over several years is not harmful, U.S. Government regulations assume that the effects of all radiation exposures are cumulative. The exposure to a member of the general public from DOE facility releases into the atmosphere is limited by the Environmental Protection Agency (EPA) to an annual dose of 10 mrem in addition to the natural background and medical radiation normally received (40 CFR 61, Subpart H). DOE also limits to 10 mrem the dose annually received from material released to the atmosphere (DOE Order 5400.5). EPA and DOE also limit the annual dose to the general public from radioactive releases to drinking water to 4 mrem (40 CFR 141; DOE Order 5400.5). The annual dose from all radiation sources from a site is limited by the EPA to 25 mrem (40 CFR 190). The DOE annual limit of radiation dose to a member of the general public from all DOE facilities is 100 mrem total, from all pathways (DOE Order 5400.5). For people working in an occupation that involves radiation, DOE and the Nuclear Regulatory Commission (NRC) limit doses to 5 rem (5,000 mrem) in any one year (10 CFR 20; 10 CFR 835).

### E.2.1.2 *Health Effects*

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this PEIS places much emphasis on the consequences of exposure to radiation, even though the effects of radiation exposure under most circumstances evaluated in this PEIS are small. This section explains the basic concepts used in the evaluation of radiation effects in order to provide the background for later discussion of impacts.

Radiation can cause a variety of ill-health effects in people. The most significant ill-health effect to depict the consequences of environmental and occupational radiation exposure is induction of cancer fatalities. This effect is referred to as "latent" cancer fatalities because the cancer may take many years to develop and for death to occur and may not actually be the cause of death. In the discussions which follow, it should be noted that all fatal cancers are latent and the term "latent" is not used.

Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects rather than genetic effects. Therefore, for this PEIS, only the somatic risks are presented. The somatic risks of most importance are the induction of cancers. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer

diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. However, such cancers also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because of the readily available data for cancer mortality rates and the relative scarcity of prospective epidemiologic studies, somatic effects leading to cancer fatalities rather than cancer incidence are presented in this PEIS. The numbers of cancer fatalities can be used to compare the risks among the various alternatives.

The fatal cancer risk estimators presented in this appendix for radiation technically apply only to low-Linear Energy Transfer radiation (gamma rays and beta particles). However, on a per rem rather than a per rad basis, the fatal risk estimators are higher for this type of radiation than for high-Linear Energy Transfer radiation (alpha particles). In this PEIS, the low-Linear Energy Transfer risk estimators are conservatively assumed to apply to all radiation exposures.

The National Research Council's Committee on the Biological Effects of Ionizing Radiations has prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposures. The latest of these reports, *Health Effects of Exposure to Low Levels of Ionizing Radiation BEIR V*, published in 1990, provides the most current estimates for excess mortality from leukemia and cancers other than leukemia expected to result from exposure to ionizing radiation. The BEIR V report updates the models and risk estimates provided in the earlier report of the BEIR III Committee, *The Effects of Populations of Exposure to Low-Levels of Ionizing Radiation,* published in 1980. BEIR V models were developed for application to the U.S. population.

BEIR V provides estimates that are consistently higher than those in BEIR III. This is attributed to several factors including the use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional follow-up studies of the atomic bomb survivors and other cohorts. BEIR III employs constant relative and absolute risk models, with separate coefficients for each of several sex and age-at-exposure groups, while BEIR V develops models in which the excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population, while BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach.

The models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data including the Japanese atomic bomb survivors, ankylosis spondylitis patients, Canadian and Massachusetts fluoroscopy patients (breast cancer), New York postpartum mastitis patients (breast cancer), Israel Tinea Capitis patients (thyroid cancer), and Rochester thymus patients (thyroid cancer). Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although results of analyses of the ankylosis spondylitis patients were considered. Atomic bomb survivor analyses were based on revised dosimetry with an assumed Relative Biological Effectiveness of 20 for neutrons, and were restricted to doses less than 400 rads. Estimates of risks of fatal cancers other than leukemia were obtained by totaling the estimates for breast cancer, respiratory cancer, digestive cancer and other cancers.

**Risk Estimates for Doses Received During an Accident.** BEIR V includes risk estimates for a single exposure of 10 rem to a population of 100,000 people ($10^6$ person-rem). In this case, fatality estimates for leukemia, breast cancer, respiratory cancer, digestive cancer, and other cancers are given for both sexes and nine age-at-exposure groups. These estimates, based on the linear model, are summarized in table E.2.1.2–1. The average risk estimate from all ages and both sexes is 885 excess cancer fatalities per million person-rem. This value has been conservatively rounded up to 1,000 excess cancer fatalities per million person-rem.

**TABLE E.2.1.2–1.—*Lifetime Risks per 100,000 Persons Exposed to a Single Exposure of 10 Rem***

| | Type of Fatal Cancer | | |
|---|---|---|---|
| Gender | Leukemia[a] | Cancers Other Than Leukemia | Total Cancers |
| Male | 220 | 660 | 880 |
| Female | 160 | 730 | 890 |
| **Average** | 190 | 695 | 885[b] |

[a] These are the linear estimates, and are double the liner-quadratic estimates provided in BEIR V for leukemia at low doses and dose-rates.

[b] This value has been rounded up to 1,000 excess cancer fatalities per million person-rem.

Source: NAS 1990a.

Although values for other health effects are not presented in this PEIS, the risk estimators for non-fatal cancers and for genetic disorders to future generations are estimated to be approximately 200 and 260 per million person-rem, respectively. These values are based on information presented in the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP Publication 60) and are seen to be 20 percent and 26 percent, respectively, of the fatal cancer estimator. Thus, for example, if the number of excess fatal cancers is projected to be "X," the number of excess genetic disorders would be 0.26 times "X."

**Risk Estimates for Doses Received During Normal Operation.** For low doses and dose rates, a linear-quadratic model was found to provide a significantly better fit to the data for leukemia than a linear one, and leukemia risks were based on a linear-quadratic function. This reduces the effects by a factor of two over estimates that are obtained from the linear model. For other cancers, linear models were found to provide an adequate fit to the data, and were used for extrapolation to low doses. However, the BEIR V Committee recommended reducing these linear estimates by a factor between 2 and 10 for doses received at low dose rates. For this PEIS, a risk reduction factor of two was adopted for conservatism.

Based on the above discussion, the resulting risk estimator would be equal to half the value observed for accident situations or approximately 500 excess fatal cancer per million person-rem (0.0005 excess fatal cancer per person-rem). This is the risk value used in this PEIS to calculate fatal cancers to the general public during normal operations. For workers, a value of 400 excess fatal cancers per million person-rem (0.0004 excess fatal cancer per person-rem) is used in this PEIS. This lower value reflects the absence of children in the workforce. Again, based on information provided in the *1990 Recommendations of the International Commission of Radiological Protection* (ICRP Publication 60), the health risk estimators for nonfatal cancer and genetic disorders among the public are 20 percent and 26 percent, respectively, of the fatal cancer risk estimator. For workers they are both 20 percent of the fatal cancer risk estimator. For this PEIS, only fatal cancers are presented.

The risk estimates may be applied to calculate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to natural background radiation (0.3 rem per year), 15 latent cancer fatalities per year would be inferred to be caused by the radiation (100,000 persons x 0.3 rem per year x 0.0005 latent cancer fatalities per person-rem = 15 latent cancer fatalities per year).

Sometimes, calculations of the number of excess cancer fatalities associated with radiation exposure do not yield whole numbers and, especially in environmental applications, may yield numbers less than 1.0. For example, if a population of 100,000 were exposed as above, but to a total dose of only 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.05 (100,000 persons x 0.001 rem x 0.0005 latent cancer fatalities/person-rem = 0.05 latent fatal cancers).

How should one interpret a nonintegral number of latent cancer fatalities, such as 0.05? The answer is to interpret the result as a statistical estimate. That is, 0.05 is the *average* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person (0 people) would incur a latent cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 latent fatal cancer would result; in exceptionally few groups, 2 or more latent fatal cancers would occur. The *average* number of deaths over all the groups would be 0.05 latent fatal cancers (just as

the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 latent cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to background radiation over a lifetime. The "number of latent cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem per year is the following:

> 1 person x 0.3 rem/year x 72 years x 0.0005 latent cancer fatalities/person-rem = 0.011 latent cancer fatalities.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure on the exposed individual would produce a 1.1-percent chance that the individual might incur a latent fatal cancer caused by the exposure. Presented another way, this method estimates that approximately 1.1 percent of the population might die of cancers induced by the radiation background.

### E.2.2 Methodology for Estimating Radiological Impacts of Normal Operation

The radiological impacts of normal operation of reactors and support facilities were calculated using Version 1.485 of the GENII computer code. Site-specific and technology-specific input data were used, including location, meteorology, population, food production and consumption, and source terms. The GENII code was used for analysis of normal operations, and design basis accidents. Section E.2.2.1 briefly describes GENII and outlines the approach used for normal operations. The approach used for design basis accidents is discussed in appendix F.

#### E.2.2.1 *GENII Computer Code*

The GENII computer model, developed by Pacific Northwest Laboratory for the U.S. Department of Energy, is an integrated system of various computer modules which analyze environmental contamination resulting from acute or chronic releases to, or initial contamination in, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII computer model is well documented for assumptions, technical approach, methodology, and quality assurance issues (PNL 1988a). The GENII computer model has gone through extensive quality assurance and quality control steps. These include the comparison of results from model computations against those from hand calculations, and the performance of internal and external peer reviews. Recommendations given in these reports were incorporated into the final GENII computer model, as deemed appropriate.

For this PEIS only the ENVIN, ENV, and DOSE computer modules were used. The codes are connected through data transfer files. The output of one code is stored in a file that can be used by the next code in the system. In addition, a computer code called CREGENII was prepared to aid and assist the user with the preparation of input files into GENII.

**CREGENII.** The CREGENII code helps the user, through a series of interactive menus and questions, to prepare a text input file for the environmental dosimetry programs. In addition, CREGENII prepares a batch processing file to manage the file handling needed to control the operations of subsequent codes and to prepare an output report.

**ENVIN.** The ENVIN module of the GENII code controls the reading of the input files prepared by CREGENII and organizes the input for optimal use in the environmental transport and exposure module, ENV. The ENVIN code interprets the basic input, reads the basic GENII data libraries and other optional input files, and organizes the input into sequential segments on the basis of radionuclide decay chains.

A standardized file that contains scenario, control, and inventory parameters is used as input to ENVIN. Radionuclide inventories can be entered as functions of releases to air or water, concentrations in basic environmental media (air, soil, or water), or concentrations in foods. If certain atmospheric dispersion options have been selected, this module can generate tables of atmospheric dispersion parameters that will be used in later calculations. If the finite plume air submersion option is requested in addition to the atmospheric dispersion calculations, preliminary energy-dependent finite plume dose factors also are prepared. The ENVIN module prepares the data transfer files that are used as input by the ENV module; ENVIN generates the first portion of the cal-

culation documentation—the run input parameters report.

**ENV.** The ENV module calculates the environmental transfer, uptake, and human exposure to radionuclides that result from the chosen scenario for the user specified source term. The code reads the input files from ENVIN and then, for each radionuclide chain, sequentially performs the precalculations to establish the conditions at the start of the exposure scenario. Environmental concentrations of radionuclides are established at the beginning of the scenario by assuming decay of preexisting sources, considering biotic transport of existing subsurface contamination, and defining soil contamination from continuing atmospheric or irrigation depositions. Then, for each year of postulated exposure, the code estimates air, surface soil, deep soil, groundwater, and surface water concentrations of each radionuclide in the chain. Human exposures and intakes of each radionuclide are calculated for: 1) pathways of external exposure from finite atmospheric plumes, 2) inhalation, 3) external exposure from contaminated soil, sediments, and water, 4) external exposure from special geometries, and 5) internal exposures from consumption of terrestrial foods, aquatic foods, drinking water, animal products, and inadvertent intake of soil. The intermediate information on annual media concentrations and intake rates are written to data transfer files. Although these may be accessed directly, they are usually used as input to the DOSE module of GENII.

GENII is a general purpose computer code used to model dispersion, transport, and long-term exposure effects of specific radionuclides and pathways. Sophisticated codes such as UFOTRI and ETMOD (Environmental Tritium Model) are used exclusively for modelling tritium transport and dosimetry. The UFOTRI and ETMOD codes were not chosen for use in this PEIS due to the lack of information on detailed facility design and on the breakdown of tritium into elemental and tritiated water forms, and because these codes cannot be used for modeling the exposure effects of radionuclides other than tritium. GENII was chosen because it can model both air and surface transport pathways and is not restricted to any radionuclides.

**DOSE.** The DOSE module reads the annual intake and exposure rates defined by the ENV module and converts the data to radiation dose. External dose is calculated with precalculated factors from the EXTDF module or from a data file prepared outside of GENII. Internal dose is calculated with precalculated factors from the INTDF module.

**EXTDF.** The EXTDF module calculates the external dose-rate factors for submersion in an infinite cloud of radioactive materials, immersion in contaminated water, and direct exposure to plane or slab sources of radionuclides. EXTDF was not used. Instead, the dose rate factors listed in *External Dose Rate Factors for Calculation of Dose to the Public* (DOE/EH-0070) were used for this PEIS.

**INTDF.** Using the *Limits for Intakes of Radionuclides by Workers* (ICRP Publication 30) model, the INTDF module calculates the internal (inhalation and ingestion) dose conversion factors of radionuclides for specific organs. The factors generated by INTDF were used for the calculations presented in this PEIS.

### E.2.2.2 *Data and Assumptions*

In order to perform the dose assessments for this PEIS, different types of data must be collected and/or generated. In addition, calculational assumptions have to be made. This section discusses the data collected and/or generated for use in the dose assessment and assumptions made for this PEIS.

**Meteorological Data.** The meteorological data used for all 5 sites were in the form of joint frequency data files. A joint frequency data file is a table listing the fractions of time the wind blows in a certain direction, at a certain speed, and within a certain stability class. The joint frequency data files were based on measurements over a 1-year period at various locations and at different heights at the sites. Average meteorological conditions (averaged over the 1-year period) were used for normal operation. For use in design basis accidents, the 50 percentile option was used. Meteorological data are presented in *Health Risk Data* (1995).

**Population Data.** Population distributions were based on *1990 Census of Population and Housing* data. Projections were determined for the years 2010, 2030, and 2050 for areas within 80 kilometers of the proposed facilities at each candidate site. These years of analysis were selected as representa-

tive of the start of operations at tritium supply and recycling facilities, the midplant-life phase, and the end of plant-life phase, respectively. The population was spatially distributed on a circular grid with 16 directions and 10 radial distances up to 80 kilometers. The grid was centered on the facility from which the radionuclides were assumed to be released. Population data are presented in *Health Risk Data*. The site population at the midlife of operation (2030) was assumed to be representative of the population over the 40-year operational period and was used in the impact assessments.

**Source Term Data.** The source terms (quantities of radionuclides released to the environment over a given period) were estimated on the basis of latest conceptual designs of facilities and experience with similar facilities. The source terms used to generate the estimated impacts of normal operation are provided in section E.2.3 for the tritium supply technologies and recycling facilities which could be located at any of the five sites. Source terms for site dependent facilities are presented in sections E.2.3.2 through E.2.3.6.

**Food Production and Consumption Data.** Data from the *1987 Census of Agriculture* was used to generate site-specific data for food production. Food production was spatially distributed on the same circular grid as was used for the population distributions. The consumption rates were those used in GENII for the maximum individual and average individual. People living within the 80 kilometer assessment area were assumed to consume only food grown in that area.

**Calculational Assumptions.** Dose assessments were performed for members of the general public and workers. Dose assessments for members of the public were performed for two different types of receptors considered in this PEIS: a maximally exposed offsite individual and the general population living within 50 miles of the facility. It was assumed that the maximally exposed individual was located at a position on the site boundary that would yield the highest impacts during normal operation of a given alternative. If more than one facility was assumed operating at a site, the dose to this individual from each facility was calculated. The doses were then summed to give the total dose to this individual. A 50-mile population dose was calculated for each operating facility at a site. These doses were then added to give the total population dose at that site.

To estimate the radiological impacts from normal operation of reactors and support facilities, additional assumptions and factors were considered in using GENII, as follows:

- No prior deposition of radionuclides on ground surfaces was assumed.
- For the maximally exposed off-site individual, the annual exposure time to the plume and to soil contamination was 0.7 years (NRC 1977b).
- For the population, the annual exposure time to the plume and to soil contamination was 0.5 years (NRC 1977b).
- A semi-infinite/finite plume model was used for air immersion doses. Other pathways evaluated were ground exposure, inhalation, ingestion of food crops and animal products contaminated by either deposition of radioactivity from the air or irrigation, ingestion of fish and other aquatic food raised in contaminated water, swimming and boating in contaminated surface water, and drinking contaminated water. It should be noted that not all pathways were available at every site.
- For atmospheric releases it was assumed that ground level releases would occur for all tritium supply and recycling facilities. For site dependent facilities, reported release heights were used and assumed to be the effective stack height. Use of the effective stack height negates plume rise thereby making the resultant doses conservative.
- The calculated doses were 50-year committed doses from 1 year of intake.
- Resuspension of particulates was not considered because prior calculations of dust loading in the atmosphere showed

that this pathway was negligible compared to others.

The exposure, uptake, and usage parameters used in the GENII model are provided in tables E.2.2.2–1 through E.2.2.2–4.

Annual average doses to workers for No Action at Idaho National Engineering Laboratory (INEL), Nevada Test Site (NTS), and Pantex Plant (Pantex) were based on measured values received by radiation workers during the 1989 to 1992 time period. The average dose received by a worker at these sites in 2010 was assumed to remain the same as the annual average during the 1982 to 1992 period. The total workforce dose in 2010 was calculated by multiplying the average worker dose by the projected number of workers in 2010. For ORR and SRS, worker dose projections provided by the sites were used.

Doses to workers directly associated with tritium supply technologies and recycling facilities were taken from the reports prepared by Fluor Daniel, Inc., and Sandia National Laboratories, New Mexico. To obtain the total workforce dose at a site with a particular tritium supply technology and recycling facilities in operation, the site dose from No Action was added to that from the tritium supply technologies and recycling facilities being evaluated. The average dose to a site worker was then calculated by dividing this dose by the total number of radiation workers at the site.

All doses to workers include a component associated with the intake of radioactivity into the body and another component resulting from external exposure to direct radiation.

### E.2.2.3 *Health Effects Calculations*

Doses calculated by GENII were used to estimate health effects using the risk estimators presented in section E.2.1.2. The incremental cancer fatalities in the general population and groups of workers due to radiation exposure were therefore estimated by multiplying the collective combined effective dose equivalent by 0.0005 and 0.0004 fatal cancers/person-rem, respectively. In this PEIS, the collective combined effective dose equivalent is the sum of the collective committed effective dose equivalent (internal dose) and the collective effective dose equivalent (external dose), section E.2.1.1.

Although health risk factors are statistical factors and therefore not strictly applicable to individuals, they have been used in the past to estimate the incremental risk to an individual from exposure to radiation. Therefore, the factor of 0.0005 and 0.0004 per rem of individual committed effective dose equivalent for a member of the public and for a worker, respectively, have also been used in this PEIS to calculate the individual's incremental fatal cancer risk from exposure to radiation.

For the public, the health effects expressed in this PEIS are the risk of fatal cancers to the maximally exposed individual and the number of fatal cancers to the 50-mile population from exposure to radioactivity released from any site over the 40-year operational period. For workers, the health effects expressed are the risk to the average worker at a site and the number of fatal cancers to all workers at that site from 40 years of site operations.

**TABLE E.2.2.2–1.—*GENII Exposure Parameters to Plumes and Soil Contamination***

| Maximal Individual | | | | General Population | | | | |
|---|---|---|---|---|---|---|---|---|
| External Exposure (hours) | | Inhalation of Plume | | External Exposure (hours) | | | Inhalation of Plume | |
| Plume | Soil Contamination | Exposure Time (hours) | Breathing Rate (cc/sec) | Plume | Soil Contamination | | Exposure Time (hours) | Breathing Rate (cc/sec) |
| 6,136 | 6,136 | 6,136 | 270 | 4,383 | 4,383 | 4,383 | 4,383 | 270 |

Source: HNUS 1995a.

**TABLE E.2.2.2–2.—*GENII Usage Parameters for Consumption of Terrestrial Food***

| | Maximum Individual Consumption | | | | Maximum Individual Consumption | | | |
|---|---|---|---|---|---|---|---|---|
| Food Type | Growing Time (days) | Yield ($kg/m^2$) | Holdup Time (days) | Rate (kg/yr) | Growing Time (days) | Yield ($kg/m^2$) | Holdup Time (days) | Rate (kg/yr) |
| Leafy Vegetables | 90.0 | 1.5 | 1.0 | 30.0 | 90.0 | 1.5 | 14.0 | 15.0 |
| Root Vegetables | 90.0 | 4.0 | 5.0 | 220.0 | 90.0 | 4.0 | 14.0 | 140.0 |
| Fruit | 90.0 | 2.0 | 5.0 | 330.0 | 90.0 | 2.0 | 14.0 | 64.0 |
| Grains/Cereals | 90.0 | 0.8 | 180.0 | 80.0 | 90.0 | 0.8 | 180.0 | 72.0 |

Source: HNUS 1995a.

**TABLE E.2.2.2–3.—*GENII Usage Parameters for Consumption of Animal Products***

| | Maximum Individual | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Human Consumption | | Stored Feed | | | | Fresh Forage | | | |
| Food Type | Rate (kg/yr) | Holdup Time (days) | Diet Fraction | Growing Time (days) | Yield (kg/m$^3$) | Storage Time (days) | Diet Fraction | Growing Time (days) | Yield (kg/m$^3$) | Storage Time (days) |
| Beef | 80.0 | 15.0 | 0.25 | 90.0 | 0.80 | 180.0 | 0.75 | 45.0 | 2.00 | 100.0 |
| Poultry | 18.0 | 1.0 | 1.00 | 90.0 | 0.80 | 180.0 | | | | |
| Milk | 270.0 | 1.0 | 0.25 | 45.0 | 2.00 | 100.0 | 0.75 | 30.0 | 1.50 | 0.0 |
| Eggs | 30.0 | 1.0 | 1.00 | 90.0 | 0.80 | 180.0 | | | | |
| | General Population | | | | | | | | | |
| Beef | 70.0 | 34.0 | 0.25 | 90.0 | 0.80 | 180.0 | 0.75 | 45.0 | 2.00 | 100.0 |
| Poultry | 8.5 | 34.0 | 1.00 | 90.0 | 0.80 | 180.0 | | | | |
| Milk | 230.0 | 4.0 | 0.25 | 45.0 | 2.00 | 100.0 | 0.75 | 30.0 | 1.50 | 0.0 |
| Eggs | 20.0 | 18.0 | 1.00 | 90.0 | 0.80 | 180.0 | | | | |

Source: HNUS 1995a.

**TABLE E.2.2.2–4.—*GENII Usage Parameters for Aquatic Activities***

| | Maximum Individual | | | General Population | | |
|---|---|---|---|---|---|---|
| Activity | Transit Time to Usage Point (days) | Holdup Time (days) | Usage Rate (per year) | Transit Time to Usage Point (days) | Holdup Time (days) | Usage Rate |
| Drinking Water | 0.0 | 0.0 | 730 liters | 0.0 | 0.0 | Site dependent |
| Swimming | 0.0 | 0.0 | 100 hours | 0.0 | 0.0 | Site dependent |
| Boating | 0.0 | 0.0 | 100 hours | 0.0 | 0.0 | Site dependent |
| Shoreline | 0.0 | 0.0 | 500 hours | 0.0 | 0.0 | Site dependent |
| Ingestion of Fish | 0.0 | 0.0 | 40 kg | 0.0 | 0.0 | Site dependent |
| Ingestion of Mollus | 0.0 | 0.0 | 6.9 kg | 0.0 | 0.0 | Site dependent |
| Ingestion of Crusta | 0.0 | 0.0 | 6.9 kg | 0.0 | 0.0 | Site dependent |
| Ingestion of Plants | 0.0 | 0.0 | 6.9 kg | 0.0 | 0.0 | Site dependent |

Source: HNUS 1995a.

### E.2.3 New Tritium Supply and Recycling Facilities Information

This section presents source terms and descriptions of radiological releases to the environment from the normal operation of tritium supply and recycling facilities at Idaho National Engineering Laboratory (INEL), Nevada Test Site (NTS), the Oak Ridge Reservation (ORR), Pantex Plant (Pantex), and the Savannah River Site (SRS). In-plant worker doses are also presented.

Manufacturing and processing of tritium for use in nuclear weapons is carried out at tritium supply and recycling facilities. There are four different technologies proposed for the production of tritium considered in this PEIS. These are a Heavy-Water Reactor (HWR), a Modular High Temperature Gas-Cooled Reactor (MHTGR), an Advanced Light Water Reactor (ALWR), and Accelerator Production of Tritium (APT). In addition to the reactors, fuel fabrication facilities for the HWR and MHTGR would need to be built to supply fuel for those two types of reactors. Fuel for the ALWR would be procured commercially. For each technology that is proposed for the production of tritium, a tritium extraction facility is needed to remove tritium from the targets.

The tritium recycling facility could be collocated with the new tritium supply facility or be located at SRS. This facility processes the tritium received from the tritium supply and from the dismantling of nuclear weapons.

For the purposes of this PEIS, the radiological impacts to the public of fuel and target fabrication can be ignored because there are no doses associated with target fabrication and the releases from HWR and MHTGR fuel fabrication are much smaller than from reactor operations. Because the ALWR fuel would be procured commercially, the radiological impacts to workers and the public associated with fuel preparation would not occur at the reactor site and would have already been addressed in environmental statements or reports for the fuel manufacturer.

The following subsections present the radiological releases from the facilities associated with tritium supply technologies and recycling facilities. The resulting doses to the public are presented in sections E.2.4 through E.2.8 since they are site dependent. However, because worker doses are dependent on the tritium supply alone, they are included in the following paragraphs. Table E.2.3–1 presents the details of the worker impacts for each reactor/accelerator combination.

#### E.2.3.1 *Heavy Water Reactor*

The *Data Report on Heavy Water Reactor* (February 1995) describes the HWR considered for this PEIS. Included in the report are the radioactive releases to both the atmosphere and surface water for a "wet" site (ORR and SRS). For a "dry" site (INEL, NTS, and Pantex), it was conservatively assumed that all like radioactive discharges to the surface water at ORR and SRS would be released into the atmosphere. Table E.2.3.1–1 presents these releases.

The doses to the worker population for 1 year of operation of the HWR and all its support facilities was calculated to be 41 person-rem. An estimated additional 0.66 fatal cancers could result from 40 years of operation. The average worker dose and health effects were calculated to be 60 mrem and a risk of fatal cancer of $2.4 \times 10^{-5}$ from 1 year of operation.

TABLE E.2.3–1.—*Estimated Annual In-Plant Worker Doses and Resulting Health Effects for Various Tritium Supply Technologies and Recycling Facilities*

| Facility | HWR | MHTGR | ALWR/Large | ALWR/Small | APT | |
|---|---|---|---|---|---|---|
| | | | | | Helium-3 Target System | SILC Target System |
| **Fuel and Target Fabrication** | | | | | | |
| Number of badged workers | 49 | 49 | 0 | 0 | 0 | 0 |
| Person-rem | 2.7 | 0.3 | 0 | 0 | 0 | 0 |
| Average exposure, mrem | 55 | 5 | 0 | 0 | 0 | 0 |
| **Reactor and Tritium Extraction** | | | | | | |
| Number of badged workers | 230 | 180 | 210 | 125 | 282 | 275 |
| Person-rem | 37 | 28 | 170 | 100 | 51.8 | 52.4 |
| Average exposure, mrem | 161 | 156 | 810 | 800 | 184 | 191 |
| **Tritium Recycling** | | | | | | |
| Number of badged workers | 400 | 400 | 400 | 400 | 400 | 400 |
| Person-rem | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| Average exposure, mrem | 4 | 4 | 4 | 4 | 4 | 4 |
| **Totals** | | | | | | |
| Number of badged workers | 679 | 629 | 610 | 525 | 682 | 675 |
| Person-rem | 41 | 30 | 172 | 102 | 53 | 54 |
| Average exposure, mrem | 60 | 48 | 281 | 194 | 78 | 80 |
| Annual risk of fatal cancer (average worker) | $2.4 \times 10^{-5}$ | $1.9 \times 10^{-5}$ | $1.1 \times 10^{-4}$ | $7.8 \times 10^{-5}$ | $3.1 \times 10^{-5}$ | $3.2 \times 10^{-5}$ |
| 40-year plant life, risk of fatal cancers | $9.7 \times 10^{-4}$ | $7.6 \times 10^{-4}$ | $4.5 \times 10^{-3}$ | $3.1 \times 10^{-3}$ | $1.2 \times 10^{-3}$ | $1.3 \times 10^{-3}$ |
| Additional fatal cancers annually (all workers) | 0.016 | 0.012 | 0.069 | 0.041 | 0.021 | 0.022 |
| 40-year plant life, additional fatal cancers | 0.66 | 0.48 | 2.8 | 1.6 | 0.85 | 0.86 |

Note: SILC - Spallation-induced lithium conversion.
Source: DOE 1995d; DOE 1995f; DOE 1995g; SNL 1995a.

**TABLE E.2.3.1–1.—*Annual Radioactive Releases During Normal Operation from Heavy Water Reactor (curies)***

| | Wet Site Releases | | Dry Site Releases | | Wet Site Releases | | Dry Site Releases |
|---|---|---|---|---|---|---|---|
| Isotope | Liquid | Air | Air | Isotope | Liquid | Air | Air |
| H-3 | $1.0x10^{3}$ | $6.0x10^{3}$ | $7.0x10^{3}$ | Sb-124 | $1.1x10^{-3}$ | 0.0 | $1.1x10^{-3}$ |
| C-14 | 0.0 | 7.3 | 7.3 | Sb-125 | $1.1x10^{-3}$ | 0.0 | $1.1x10^{-3}$ |
| Na-24 | 0.075 | 0.0 | 0.075 | I-129 | $7.5x10^{-12}$ | 0.0 | $7.5x10^{-12}$ |
| P-32 | $5.9x10^{-6}$ | 0.0 | $5.9x10^{-6}$ | I-131 | $1.8x10^{-3}$ | $8.0x10^{-3}$ | $9.8x10^{-3}$ |
| S-35 | $2.2x10^{-5}$ | 0.0 | $2.2x10^{-5}$ | I-32 | $1.1x10^{-3}$ | 0.0 | $1.1x10^{-3}$ |
| Ar-41 | 0.0 | 34 | 34 | I-133 | $4.2x10^{-3}$ | 0.13 | 0.13 |
| Cr-51 | 0.065 | 0.0 | 0.065 | I-134 | $6.7x10^{-4}$ | 0.0 | $6.7x10^{-4}$ |
| Mn-54 | $9.3x10^{-6}$ | 0.0 | $9.3x10^{-6}$ | I-135 | $3.3x10^{-3}$ | 0.0 | $3.3x10^{-3}$ |
| Fe-59 | $8.7x10^{-5}$ | 0.0 | $8.7x10^{-5}$ | Xe-133 | 0.0 | 400 | 400 |
| Co-58 | $8.0x10^{-4}$ | 0.0 | $8.0x10^{-4}$ | Xe-135m | 0.0 | 5.5 | 5.5 |
| Co-60 | $8.9x10^{-4}$ | $9.6x10^{-5}$ | $9.9x10^{-4}$ | Xe-135 | 0.0 | 13 | 13 |
| Zn-65 | $9.3x10^{-6}$ | 0.0 | $9.3x10^{-6}$ | Cs-134 | $3.1x10^{-3}$ | 0.0 | $3.1x10^{-3}$ |
| Kr-85m | 0.0 | 3.6 | 3.6 | Cs-137 | 0.061 | 0.0 | 0.061 |
| Kr-85 | 0.0 | 0.80 | 0.80 | Ba-140 | $3.0x10^{-3}$ | 0.0 | $3.0x10^{-3}$ |
| Kr-87 | 0.0 | 7.9 | 7.9 | La-140 | $3.2x10^{-6}$ | 0.0 | $3.2x10^{-6}$ |
| Kr-88 | 0.0 | 10 | 10 | Ce-141 | $8.7x10^{-3}$ | 0.0 | $8.7x10^{-3}$ |
| Sr-89 | $1.3x10^{-5}$ | 0.0 | $1.3x10^{-5}$ | Ce-143 | $2.2x10^{-3}$ | 0.0 | $2.2x10^{-3}$ |
| Sr-90 | 0.19 | $4.0x10^{-4}$ | 0.19 | Ce-144 | $6.7x10^{-3}$ | 0.0 | $6.7x10^{-3}$ |
| Sr-91 | $2.0x10^{-3}$ | 0.0 | $2.0x10^{-3}$ | Pm-147 | $6.6x10^{-7}$ | 0.0 | $6.6x10^{-7}$ |
| Sr-92 | $7.8x10^{-4}$ | 0.0 | $7.8x10^{-4}$ | U-237 | $6.3x10^{-5}$ | 0.0 | $6.3x10^{-5}$ |
| Nb-95 | $8.6x10^{-6}$ | 0.0 | $8.6x10^{-6}$ | Np-238 | $3.6x10^{-5}$ | 0.0 | $3.6x10^{-5}$ |
| Zr-95 | 0.018 | 0.0 | 0.018 | Np-239 | 0.039 | 0.0 | 0.039 |
| Ru-103 | $8.8x10^{-4}$ | 0.0 | $8.8x10^{-4}$ | Pu-239 | 0.012 | 0.0 | 0.012 |

Source: DOE 1995d.

### E.2.3.2 *Modular High Temperature Gas-Cooled Reactor*

The *Data Report on Modular High Temperature Gas-Cooled Reactor Tritium Supply Plant,* February 1995, describes the MHTGR considered for this PEIS. Included in the report are the radioactive releases to the atmosphere. There are no liquid radioactive releases. Table E.2.3.2–1 presents the atmospheric releases.

The doses to the worker population for one year of operation of the MHTGR and all its support facilities was calculated to be 30 person-rem. An additional 0.48 fatal cancers could result from 40 years of operation. The annual average worker dose was calculated to be 48 mrem. A fatal cancer risk of $7.6x10^{-4}$ could result to this worker from 40 years of operation. These doses and health effects are given in table E.2.3–1.

### E.2.3.3 *Advanced Light Water Reactor*

The *Data Report on Advanced Light Water Reactor Tritium Supply Plant,* February 1995, evaluated the radiological emissions from the production of tritium using two different advanced light water reactors (a Large ALWR of about 1,100 to 1,300 MWe and a Small ALWR of about 600 MWe). The releases from each are discussed below for both a "dry site" (INEL, NTS, and Pantex) and a "wet site" (ORR and SRS).

#### E.2.3.3.1 *Large Advanced Light Water Reactor*

Radioactive releases from a Large ALWR to both the atmosphere and surface water for a "wet site" (ORR and SRS) and to the atmosphere for a "dry site" (INEL, NTS, and Pantex) are presented in table E.2.3.3.1–1. The doses and health effects to workers are given in table E.2.3–1.

**TABLE E.2.3.2–1.—*Annual Atmospheric Radioactive Releases from Modular High Temperature Gas-Cooled Reactor (curies)***

| Isotope | Atmospheric Release | Isotope | Atmospheric Release | Isotope | Atmospheric Release |
|---|---|---|---|---|---|
| H-3 | $2.1 \times 10^{3}$ | Mo-99 | $2.0 \times 10^{-7}$ | I-132 | 0.31 |
| Kr-85m | 1.8 | Tc-99m | $1.8 \times 10^{-6}$ | I-133 | 0.17 |
| Kr-85 | $4.1 \times 10^{-3}$ | Ru-103 | $8.2 \times 10^{-9}$ | I-134 | 0.75 |
| Kr-87 | 3.7 | Ru-105 | $7.9 \times 10^{-7}$ | I-135 | 0.27 |
| Kr-88 | 5.6 | Ru-106 | $7.9 \times 10^{-11}$ | Xe-133 | 0.86 |
| Kr-89 | 2.1 | Rh-105 | $9.4 \times 10^{-8}$ | Xe-135 | 1.8 |
| Kr-90 | 0.86 | Ag-10m | $8.6 \times 10^{-13}$ | Cs-134 | $1.2 \times 10^{-8}$ |
| Rb-86 | $6.4 \times 10^{-4}$ | Sb-127 | $4.5 \times 10^{-9}$ | Cs-136 | $3.6 \times 10^{-9}$ |
| Sr-89 | $4.5 \times 10^{-4}$ | Sb-129 | $5.6 \times 10^{-6}$ | Cs-137 | $4.1 \times 10^{-9}$ |
| Sr-90 | $9.0 \times 10^{-7}$ | Te-127m | $5.6 \times 10^{-5}$ | Ba-140 | $3.2 \times 10^{-8}$ |
| Sr-91 | $1.2 \times 10^{-6}$ | Te-127 | $1.8 \times 10^{-4}$ | La-140 | $3.8 \times 10^{-7}$ |
| Y-90 | $1.1 \times 10^{-8}$ | Te-129m | $4.9 \times 10^{-4}$ | Ce-141 | $1.6 \times 10^{-8}$ |
| Y-91 | $9.0 \times 10^{-9}$ | Te-129 | 0.068 | Ce-143 | $3.6 \times 10^{-7}$ |
| Nb-95 | $1.6 \times 10^{-8}$ | Te-131m | $7.9 \times 10^{-3}$ | Ce-144 | $7.5 \times 10^{-10}$ |
| Zr-95 | $8.6 \times 10^{-9}$ | Te-132 | 0.018 | Pr-143 | $3.7 \times 10^{-8}$ |
| Zr-97 | $7.5 \times 10^{-8}$ | I-131 | 0.026 | Nd-147 | $1.9 \times 10^{-8}$ |

Source: DOE 1995e.

**TABLE E.2.3.3.1–1.—*Annual Liquid and Atmospheric Radioactive Releases from Large Advanced Light Water Reactor (curies)***

| | Wet Site Releases | | Dry Site Releases | | Wet Site Releases | | Dry Site Releases |
|---|---|---|---|---|---|---|---|
| **Isotope** | **Liquid** | **Air** | **Air** | **Isotope** | **Liquid** | **Air** | **Air** |
| H-3 | $3.8x10^{3}$ | $1.2x10^{4}$[a] | $1.6x10^{4}$ | Ru-103 | $4.4x10^{-3}$ | 0.022 | 0.027 |
| C-14 | 0.0 | 9.2 | 9.2 | Ru-106 | 0.063 | $3.5x10^{-3}$ | 0.067 |
| Na-24 | $5.5x10^{-3}$ | 0.092 | 0.097 | Rh-103m | $4.1x10^{-3}$ | 0.021 | 0.025 |
| P-32 | $1.8x10^{-4}$ | 0.025 | 0.025 | Ag-110m | $2.0x10^{-3}$ | $8.4x10^{-7}$ | $2.0x10^{-3}$ |
| Ar-41 | 0.0 | 6.8 | 6.8 | Sb-124 | $4.3x10^{-4}$ | $1.7x10^{-4}$ | $6.0x10^{-4}$ |
| Cr-51 | $6.3x10^{-3}$ | 0.89 | 0.90 | Sb-125 | 0.0 | $6.1x10^{-5}$ | $6.1x10^{-5}$ |
| Mn-54 | $4.8x10^{-3}$ | 0.62 | 0.62 | Te-129m | $1.0x10^{-4}$ | 0.041 | 0.041 |
| Fe-55 | $7.9x10^{-3}$ | 0.18 | 0.19 | Te-131m | $1.5x10^{-4}$ | 0.013 | 0.013 |
| Mn-56 | $7.5x10^{-3}$ | 0.057 | 0.064 | Te-131 | $3.4x10^{-5}$ | 0.0 | $3.4x10^{-5}$ |
| Fe-59 | $2.4x10^{-3}$ | $5.1x10^{-3}$ | $7.5x10^{-3}$ | Te-132 | $4.2x10^{-4}$ | $3.2x10^{-3}$ | $3.7x10^{-3}$ |
| Co-57 | 0.0 | $8.2x10^{-6}$ | $8.2x10^{-6}$ | I-131 | 0.033 | 0.46 | 0.49 |
| Co-58 | 0.011 | 0.033 | 0.043 | I-132 | $5.1x10^{-3}$ | 2.2 | 2.2 |
| Co-60 | 0.014 | 0.075 | 0.089 | I-133 | 0.020 | 1.8 | 1.8 |
| Ni-63 | $1.7x10^{-3}$ | $1.8x10^{-4}$ | $1.9x10^{-3}$ | I-134 | 0.017 | 3.8 | 3.8 |
| Cu-64 | 0.015 | 0.23 | 0.24 | I-135 | 0.015 | 2.4 | 2.4 |
| Zn-65 | $3.0x10^{-4}$ | 0.039 | 0.039 | Xe-131m | 0.0 | 930 | 930 |
| Kr-83m | 0.0 | $8.4x10^{-4}$ | $8.4x10^{-4}$ | Xe-133m | 0.0 | 51 | 51 |
| Kr-85m | 0.0 | 21 | 21 | Xe-133 | 0.0 | $2.7x10^{3}$ | $2.7x10^{3}$ |
| Kr-85 | 0.0 | 770 | 770 | Xe-135m | 0.0 | 390 | 390 |
| Kr-87 | 0.0 | 4.0 | 4.0 | Xe-135 | 0.0 | 440 | 440 |
| Kr-88 | 0.0 | 38 | 38 | Xe-137 | 0.0 | 500 | 500 |
| Kr-89 | 0.0 | 240 | 240 | Xe-138 | 0.0 | 400 | 400 |
| Kr-90 | 0.0 | $3.3x10^{-4}$ | $3.3x10^{-4}$ | Cs-139 | 0.0 | $3.1x10^{-5}$ | $3.1x10^{-5}$ |
| Rb-89 | $8.8x10^{-5}$ | $2.6x10^{-3}$ | $2.7x10^{-3}$ | Cs-134 | 0.027 | 0.032 | 0.059 |
| Sr-89 | $1.7x10^{-4}$ | 0.11 | 0.11 | Cs-136 | $1.5x10^{-3}$ | 0.013 | 0.015 |
| Sr-90 | $2.0x10^{-5}$ | $8.1x10^{-3}$ | $8.1x10^{-3}$ | Cs-137 | 0.037 | 0.084 | 0.12 |
| Sr-91 | $1.8x10^{-3}$ | 0.14 | 0.14 | Cs-138 | $3.7x10^{-4}$ | 0.011 | 0.012 |
| Sr-92 | $1.6x10^{-3}$ | 0.081 | 0.083 | Ba-140 | $6.9x10^{-3}$ | 0.31 | 0.31 |
| Y-90 | $6.2x10^{-6}$ | $8.1x10^{-3}$ | $8.1x10^{-3}$ | La-140 | $8.2x10^{-3}$ | 0.29 | 0.30 |
| Y-91 | $9.0x10^{-5}$ | 0.043 | 0.043 | Ce-141 | $3.1x10^{-4}$ | 0.034 | 0.034 |
| Y-91m | $3.0x10^{-5}$ | 0.0 | $3.0x10^{-5}$ | Ce-143 | $1.1x10^{-3}$ | 0.0 | $1.1x10^{-4}$ |
| Y-92 | $1.2x10^{-3}$ | 0.063 | 0.069 | Ce-144 | $6.2x10^{-3}$ | $3.5x10^{-3}$ | $9.7x10^{-3}$ |
| Y-93 | $1.8x10^{-3}$ | 0.15 | 0.15 | Pr-143 | $1.1x10^{-4}$ | 0.0 | $1.1x10^{-4}$ |
| Nb-95 | $2.1x10^{-3}$ | 0.012 | 0.014 | Pr-144 | $2.3x10^{-3}$ | $3.5x10^{-3}$ | $5.8x10^{-3}$ |
| Zr-95 | $1.3x10^{-3}$ | $9.3x10^{-3}$ | 0.011 | W-187 | $2.2x10^{-4}$ | $4.6x10^{-3}$ | $4.8x10^{-3}$ |
| Mo-99 | $1.6x10^{-3}$ | 0.60 | 0.60 | Np-239 | $6.2x10^{-3}$ | 1.9 | 1.9 |
| Tc-99m | $1.6x10^{-3}$ | 0.051 | 0.053 | | | | |

[a] Includes tritium associated with target processing.

Source: DOE 1995f.

#### E.2.3.3.2 *Small Advanced Light Water Reactor*

Radioactive releases from a Small ALWR to both the atmosphere and surface water for a "wet site" (ORR and SRS) and to the atmosphere for a "dry site" (INEL, NTS, and Pantex) are presented in table E.2.3.3.2–1.

The doses to the worker population for 1 year of operation of the Small ALWR and all its support facilities was calculated to be 102 person-rem. An additional 1.6 fatal cancers could result from 40 years of operation. The annual average worker dose was calculated to be 194 mrem. A fatal cancer risk of $3.1 \times 10^{-3}$ could result to this worker from 40 years of operation. These doses and health effects are given in table E.2.3–1.

### E.2.3.4 *Accelerator Production of Tritium*

Sandia National Laboratories, New Mexico has evaluated the radiological emissions and Los Alamos National Laboratory has assessed the possible effects of radio frequency power generated from the production of tritium using an accelerator.

Two separate tritium target designs have been proposed. The first uses targets using the same concept as in the HWR reactor; irradiation of a spallation-induced lithium conversion target. The second uses a different concept; irradiation of helium-3. The accelerator is the same design for either target system. The differences between the two target designs arise in the tritium extraction process discussed below. In addition, a "phased" accelerator with a helium target is being evaluated. Table E.2.3.4–1 presents the atmospheric releases. There are no liquid radioactive releases.

The radio frequency power generated by the APT accelerator does not produce hazardous exposures of radio frequency non-ionizing radiation to workers, nor does it interfere with radio/television or other sensitive signal equipment, on or offsite. The radio frequency power generators in the APT accelerator system are completely contained in connected, sealed, metallic enclosures. The enclosure provides

**TABLE E.2.3.4–1.—*Annual Atmospheric Releases from Accelerator Production of Tritium During Normal Operation (curies)***

| Isotope | Full APT | Phased APT |
|---|---|---|
| C-11 | 11 | 3.8 |
| N-13 | 0.49 | 0.17 |
| O-14 | $9.8 \times 10^{-16}$ | $3.5 \times 10^{-16}$ |
| O-15 | $6.5 \times 10^{-8}$ | $2.3 \times 10^{-8}$ |
| Ar-41 | 7.1 | 2.5 |

Source: SNL 1995a.

a continuous metal-sealed envelope which contains the microwave energy. Also, the accelerating cavities and attachments constitute a tightly sealed vacuum system which ensures a much greater shield than is needed for preventing leakage of radio frequency energy. Therefore, the potential for a significant level of microwave energy being radiated to the surroundings of the APT accelerator is negligible. The experience with the Los Alamos Meson Physics Facility at Los Alamos and other DOE accelerators confirms that there is minimal leakage of radio frequency power which poses no hazard to workers or to television/radio or other sensitive signal-processing equipment.

The doses to the worker population from one year of operation of the APT and all its support facilities with the spallation-induced lithium conversion target was calculated to be 54 person-rem. An additional 0.86 fatal cancers could result from 40 years of operation. The annual average worker dose was calculated to be 80 mrem. A fatal cancer risk of $1.3 \times 10^{-3}$ could result to this worker from 40 years of operation. The doses to the worker population from one year of operation of the APT and all its support facilities with the helium-3 conversion target was calculated to be 53 person-rem. An additional 0.85 fatal cancers could result from 40 years of operation. The annual average worker dose was calculated to be 78 mrem. A fatal cancer risk of $1.2 \times 10^{-3}$ could result to this workers from 40 years of operation. A Phased APT is comparable to the APT with the helium-3 conversion. The doses and health effects associated with all APT options are given in table E.2.3–1.

**TABLE E.2.3.3.2–1.—*Annual Liquid and Atmospheric Radioactive Releases from Small Advanced Light Water Reactor (curies)***

| | Wet Site Releases | | Dry Site Releases | | Wet Site Releases | | Dry Site Releases |
|---|---|---|---|---|---|---|---|
| **Isotope** | **Liquid** | **Air[a]** | **Air** | **Isotope** | **Liquid** | **Air[a]** | **Air** |
| H-3 | $9.90\times10^{3}$ | $6.30\times10^{3}$ | $1.62\times10^{4}$ | Co-57 | $7.30\times10^{-5}$ | 0.00 | $7.30\times10^{-5}$ |
| C-14 | $1.59\times10^{-4}$ | 5.95 | 5.95 | Co-58 | $8.92\times10^{-5}$ | 0.0324 | 0.0325 |
| Ar-41 | 0.00 | 5.41 | 5.41 | Co-60 | $9.19\times10^{-3}$ | 0.0757 | 0.0849 |
| Kr-83m | 0.00 | $4.05\times10^{-4}$ | $4.05\times10^{-4}$ | Fe-59 | $1.00\times10^{-4}$ | $5.14\times10^{-3}$ | $5.24\times10^{-3}$ |
| Kr-85m | 0.00 | 5.68 | 5.68 | Ni-63 | $1.41\times10^{-4}$ | $1.78\times10^{-4}$ | $3.19\times10^{-4}$ |
| Kr-85 | 0.00 | 297 | 297 | Cu-64 | $7.57\times10^{-3}$ | 0.23 | 0.237 |
| Kr-87 | 0.00 | 5.68 | 5.68 | Zn-65 | $8.92\times10^{-5}$ | 0.0378 | 0.0379 |
| Kr-88 | 0.00 | 8.65 | 8.65 | Rb-89 | $4.32\times10^{-5}$ | $2.57\times10^{-3}$ | $2.61\times10^{-3}$ |
| Kr-89 | 0.00 | 54.1 | 54.1 | Sr-89 | $1.11\times10^{-4}$ | 0.108 | 0.108 |
| Kr-90 | 0.00 | $1.54\times10^{-4}$ | $1.54\times10^{-4}$ | Sr-90 | $3.51\times10^{-5}$ | $8.11\times10^{-3}$ | $8.14\times10^{-3}$ |
| Xe-131m | 0.00 | 23 | 23 | Sr-91 | $8.92\times10^{-4}$ | 0.141 | 0.141 |
| Xe-133m | 0.00 | 0.027 | 0.027 | Sr-92 | $8.11\times10^{-4}$ | 0.0811 | 0.0819 |
| Xe-133 | 0.00 | 973 | 973 | Y-90 | $2.97\times10^{-4}$ | $8.11\times10^{-3}$ | $8.11\times10^{-3}$ |
| Xe-135m | 0.00 | 89.2 | 89.2 | Y-91 | $1.11\times10^{-4}$ | 0.0432 | 0.0434 |
| Xe-135 | 0.00 | 135 | 135 | Y-92 | $5.95\times10^{-4}$ | 0.0676 | 0.0682 |
| Xe-137 | 0.00 | 114 | 114 | Y-93 | $8.92\times10^{-4}$ | 0.151 | 0.152 |
| Xe-138 | 0.00 | 89.2 | 89.2 | Zr-95 | $8.38\times10^{-4}$ | $9.19\times10^{-3}$ | 0.01 |
| Xe-139 | 0.00 | $1.92\times10^{-4}$ | $1.92\times10^{-4}$ | Nb-95 | $1.00\times10^{-3}$ | 0.016 | 0.0126 |
| Na-24 | $2.70\times10^{-3}$ | 0.0919 | 0.0946 | Mo-99 | $8.38\times10^{-4}$ | 0.568 | 0.568 |
| P-32 | $1.81\times10^{-4}$ | 0.0251 | 0.0253 | Tc-99m | $8.11\times10^{-4}$ | 0.0514 | 0.0522 |
| Cr-51 | $7.57\times10^{-3}$ | 0.892 | 0.899 | Ru-103 | $1.81\times10^{-4}$ | 0.0224 | 0.0226 |
| Mn-54 | $2.59\times10^{-3}$ | 0.0143 | 0.0169 | Rh-103m | $8.92\times10^{-6}$ | 0.0208 | 0.0208 |
| Mn-56 | $3.78\times10^{-3}$ | 0.0568 | 0.0605 | Ru-106 | $1.30\times10^{-6}$ | 0.00 | $1.30\times10^{-6}$ |

| | Wet Site Releases | | Dry Site Releases | | Wet Site Releases | | Dry Site Releases |
|---|---|---|---|---|---|---|---|
| **Isotope** | **Liquid** | **Air** | **Air** | **Isotope** | **Liquid** | **Air** | **Air** |
| Fe-55 | $5.68\times10^{-3}$ | 0.178 | 0.184 | Rh-106 | $1.30\times10^{-6}$ | $3.51\times10^{-3}$ | $3.51\times10^{-3}$ |
| Co-56 | $5.14\times10^{-3}$ | 0.00 | $5.14\times10^{-3}$ | Aa-110m | $3.24\times10^{-4}$ | $8.38\times10^{-7}$ | $3.25\times10^{-3}$ |
| Sb-124 | $3.51\times10^{-4}$ | $7.57\times10^{-5}$ | $4.27\times10^{-4}$ | Cs-136 | $3.24\times10^{-4}$ | 0.0135 | 0.0138 |
| Sb-125 | 0.00 | 0.00 | 0.00 | Cs-137 | $8.92\times10^{-3}$ | 0.0838 | 0.927 |
| Te-129m | $1.70\times10^{-5}$ | 0.0405 | 0.0406 | Cs-138 | $1.89\times10^{-4}$ | 0.0114 | 0.0115 |
| Te-131m | $3.51\times10^{-5}$ | 0.0127 | 0.0127 | Cs-139 | 0.00 | $1.45\times10^{-5}$ | $1.45\times10^{-5}$ |
| Te-131 | 0.00 | 0.00 | 0.00 | Ba-140 | $6.76\times10^{-4}$ | 0.324 | 0.325 |
| I-131 | $3.24\times10^{-3}$ | 0.459 | 0.463 | La-140 | $1.70\times10^{-4}$ | 0.297 | 0.297 |
| Te-132 | $4.05\times10^{-6}$ | $3.24\times10^{-3}$ | $3.25\times10^{-3}$ | Ce-141 | $1.19\times10^{-4}$ | 0.0351 | 0.0353 |
| I-132 | $2.59\times10^{-3}$ | 1.70 | 1.71 | Ce-144 | $1.89\times10^{-3}$ | $3.51\times10^{-3}$ | $5.41\times10^{-3}$ |
| I-133 | 0.01 | 1.78 | 1.79 | Pr-143 | $1.30\times10^{-6}$ | 0.00 | $1.30\times10^{-6}$ |
| I-134 | $1.70\times10^{-3}$ | 2.70 | 2.70 | Pr-144 | 0.00 | $3.51\times10^{-3}$ | $3.51\times10^{-3}$ |
| Cs-134 | $6.22\times10^{-3}$ | 0.0324 | 0.0386 | W-187 | $9.46\times10^{-5}$ | $4.59\times10^{-3}$ | $4.69\times10^{-3}$ |
| I-135 | $7.57\times10^{-3}$ | 2.11 | 2.12 | Np-239 | $2.97\times10^{-3}$ | 1.95 | 1.95 |

[a] Includes tritium associated with target processing.

Source: DOE 1995f.

### E.2.3.5 *Tritium Target Extraction Facility*

This facility extracts the tritium from the targets after completion of the irradiation in either the reactor or accelerator. Table E.2.3.5–1 presents the atmospheric radiological releases. There are no liquid radioactive releases. The impacts to workers and the public associated with extraction are included in the various reactor/accelerator calculations.

**TABLE E.2.3.5–1.—*Annual Atmospheric Releases of Tritium from Various Tritium Target Extraction Facilities for Tritium Supply Technologies (curies)***

| Tritium Extraction Facility Contribution | Atmospheric Release of Tritium |
|---|---|
| Heavy Water Reactor | $5.0 \times 10^3$ |
| Modular High Temperature Gas-Cooled Reactor | $5.0 \times 10^3$ |
| Advanced Light Water Reactor | $5.0 \times 10^3$ |
| Accelerator - Helium-3 Target | 250 |
| Accelerator - Spallation-Induced Lithium Conversion Target | $5.0 \times 10^3$ |

Source: DOE 1995d; DOE 1995e; DOE 1995f; SNL 1995a.

### E.2.3.6 *Tritium Recycling Facility*

The *Data Report on Tritium Recycling Plant* (February 1995) describes the facility for the recycling of the tritium. Simply, this facility receives tritium from either the tritium supply or from dismantled weapons to purify and prepare the tritium for placement into nuclear weapons. The predicted release of radioactivity to the atmosphere is estimated to range from 5,000 to 10,000 Ci per year of tritium. For this PEIS, the higher value was assumed. There are no liquid radioactive releases. The impacts to workers are included in the various reactor/accelerator calculations.

An upgraded tritium recycle facility is being evaluated for operation at the SRS. The unconsolidated upgrade involves maintaining many functions in Building 232-H. As a potential mitigation measure a consolidated upgrade is considered which includes the relocation of all tritium processing/handling associated with tritium recycling facilities to other buildings. The predicted tritium releases to the atmosphere from the unconsolidated and consolidated upgrade options are 30,000 Ci per year and 18,000 Ci per year, respectively.

## E.2.4 Radiological Impacts at Idaho National Engineering Laboratory

This section presents the radiological impacts of the tritium supply technologies and recycling facilities at INEL. Section E.2.4.1 presents the radiological releases and resulting impacts from facilities associated with No Action. Section E.2.4.2 presents the radiological releases and resulting impacts from the facilities associated with tritium supply technologies and recycling facilities.

For purposes of radiological impact modelling, INEL was divided into five separate areas which will release radioactivity in the year 2010. All release points in each area were aggregated into a single release point. Table E.2.4–1 presents the characteristics of each of the release points including location, release height, and minimum distance and annual average dispersion to the site boundary in each of the 16 directions. In order to calculate the maximum site boundary dose, the dose from each release point to the maximum receptor associated with each of the other release points has been calculated. For example, the dose resulting from releases from the Test Reactor Area, Argonne National Laboratory-West, Waste Experimental Reduction Facility/Power Burst Facility Area, and the proposed TSS has been determined for the maximum receptor from the Central Facilities Area. Figure E.2.4–1 illustrates the location of each maximum receptor in relation to each release point. The maximum site boundary dose is then determined by the maximum dose of each of the maximum receptors. Table E.2.4–2 presents the direction, distance, and atmospheric dispersion from each release point to each of the maximum receptors. Annual radiological releases were assumed to remain constant during the 40-year operational period.

The population and food stuffs distributions centered on each release area are provided in the *Health Risk Data* report. The joint frequency distribution used for the dose assessment was based on the meteorological measurements for the year 1986 from the GRID III tower at the 10 meter height and is contained in a technical report (*Health Risk Data*).

Doses given in this section are associated with one year of operation because regulatory standards are given as annual limits. The health effects presented are for the 40-year operational period.

### E.2.4.1 *No Action*

**Atmospheric Releases.** For No Action, four of the areas have radioactive releases to the atmosphere from normal operation. Table E.2.4.1–1 presents the estimated annual atmospheric radioactive releases.

**Liquid Releases.** There are no radioactive liquid releases to the offsite environment associated with No Action.

Tables E.2.4.1–2 and E.2.4.1–3 include the radiological impacts to the maximally exposed individual and offsite population within 50 miles, respectively. The maximally exposed individual would receive an annual dose of $6.0 \times 10^{-3}$ mrem. An estimated fatal cancer risk of $1.2 \times 10^{-7}$ would result from 40 years of operation. The population within 50 miles would receive a dose of 0.037 person-rem in year 2030 (mid-life of operation). An estimated $7.4 \times 10^{-4}$ fatal cancers could result from 40 years of operation.

**Worker Doses.** Based on measured values during the time period of 1989 to 1992 (*Twenty-Second Annual Report Radiation Exposures for DOE and DOE Contractor Employees – 1989* (DOE/EH-0286P)) and subsequent yearly data reports), the annual average dose to a badged worker at INEL was calculated to be 30 mrem. It is projected that in the year 2010 and beyond, there would be 7,337 badged workers involved in No Action activities at INEL (INEL 1993a:5). The annual average dose to these workers is assumed to remain at 30 mrem; the annual total dose among all these workers would then equal 220 person-rem. From 40 years of operation, an estimated fatal cancer risk of $4.8 \times 10^{-4}$ would result to the average worker and 3.5 fatal cancers could result among all workers.

### E.2.4.2 *Tritium Supply Technologies and Recycling*

For the tritium supply technologies and recycling facilities, the impacts from the No Action facilities need to be added to the impacts from the tritium supply technologies and recycling facilities to determine the impacts from total site operation. For example, to determine the radiological impact for the addition of an HWR at INEL, the doses from No Action facilities have to be summed with the HWR doses (which includes tritium target extraction) and

the tritium recycling doses. Estimated annual atmospheric radioactive releases for the tritium supply technologies and recycling facilities are given in section E.2.3. Tables E.2.4.1–2 and E.2.4.1–3 present the radiological impacts by tritium supply technology and recycling facility. There are no radioactive liquid releases to the offsite environment associated with this alternative.

The annual doses from total site operation associated with the difference tritium supplies range from 0.11 to 0.36 mrem to the maximally exposed individual and from 23 to 73 person-rem to the 50-mile population in the year 2030. The health effects from 40 years of operation are included in both tables.

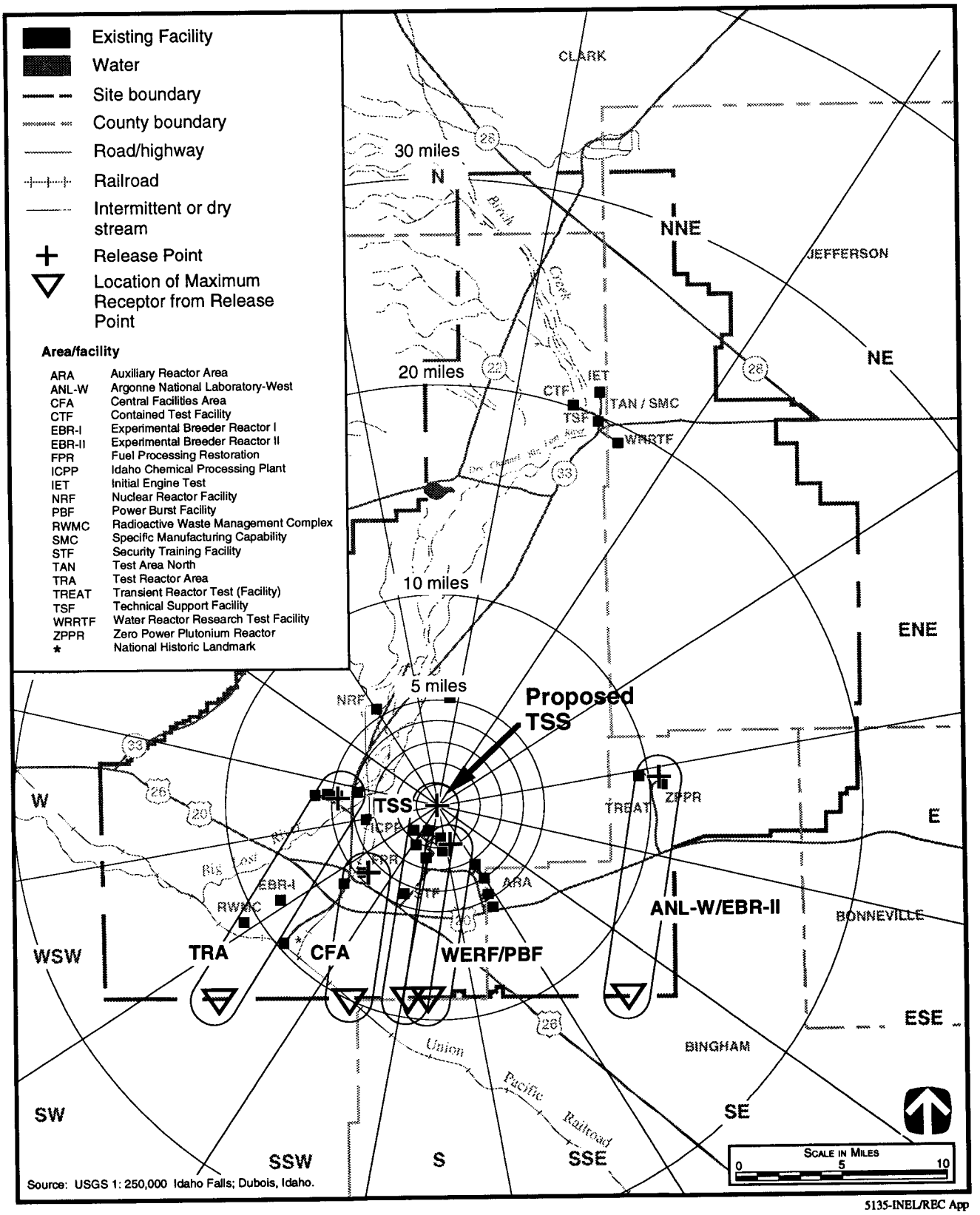



**FIGURE E.2.4–1.**—*Location of Maximum Receptors at Idaho National Engineering Laboratory.*

**TABLE E.2.4–1.—*Release Point Characteristics, Direction, Distance, and Chi/Q at Idaho National Engineering Laboratory Boundary***

| Release Point[a] | Argonne National Laboratory-West | Central Facilities Area | Test Reactor Area | Waste Experimental Reduction Facility/Power Burst Facility Area | Tritium Supply and Recycling Site | | | |
|---|---|---|---|---|---|---|---|---|
| **Latitude** | 43°35'41.63" | 43°32'4.56" | 43°35'8.17" | 43°33'3.60" | 43°34'42.60" | | | |
| **Longitude** | -112°39'18.71" | -112°56'9.95" | -112°57'46.79" | -112°51'30.95" | -112°52'5.53" | | | |
| **Release Height:** | 18.1 meters | Ground Level | 76.2 meters | 15.0 meters | Ground Level | | | |
| | | | | | | | Accident | |
| **Direction** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Annual Average Chi/Q (sec/m$^3$)** | **50 Percentile Chi/Q (sec/m$^3$)** | **95 Percentile Chi/Q (sec/m$^3$)** |
| N. | 32,636 | $1.2x10^{-8}$ | 24,783 | $1.1x10^{-8}$ | 19,099 | $3.3x10^{-9}$ | 25,459 | $8.5x10^{-9}$ | 22,328 | $1.2x10^{-8}$ | $1.2x10^{-6}$ | $5.0x10^{-6}$ |
| NNE. | 24,647 | $2.0x10^{-8}$ | 40,102 | $1.1x10^{-8}$ | 21,737 | $6.8x10^{-9}$ | 41,136 | $9.4x10^{-9}$ | 44,888 | $9.8x10^{-9}$ | $6.1x10^{-7}$ | $2.3x10^{-6}$ |
| NE. | 19,641 | $2.3x10^{-8}$ | 45,055 | $2.3x10^{-8}$ | 42,898 | $7.3x10^{-9}$ | 39,207 | $2.4x10^{-8}$ | 37,707 | $2.9x10^{-8}$ | $6.1x10^{-7}$ | $4.5x10^{-6}$ |
| ENE. | 16,056 | $2.2x10^{-8}$ | 39,301 | $2.0x10^{-8}$ | 41,932 | $4.6x10^{-9}$ | 32,888 | $2.1x10^{-8}$ | 34,097 | $2.5x10^{-8}$ | $6.6x10^{-7}$ | $5.3x10^{-6}$ |
| E. | 14,466 | $1.6x10^{-8}$ | 23,843 | $1.5x10^{-8}$ | 26,375 | $2.9x10^{-9}$ | 17,582 | $1.9x10^{-8}$ | 19,375 | $2.0x10^{-8}$ | $1.2x10^{-6}$ | $7.8x10^{-6}$ |
| ESE. | 9,003 | $2.8x10^{-8}$ | 18,763 | $1.0x10^{-8}$ | 26,410 | $1.4x10^{-9}$ | 17,858 | $8.8x10^{-9}$ | 18,696 | $1.0x10^{-8}$ | $1.5x10^{-6}$ | $6.3x10^{-6}$ |
| SE. | 5,861 | $5.0x10^{-8}$ | 11,883 | $9.4x10^{-9}$ | 19,094 | $1.0x10^{-9}$ | 14,536 | $5.9x10^{-9}$ | 18,259 | $5.2x10^{-9}$ | $1.7x10^{-6}$ | $6.5x10^{-6}$ |
| SSE. | 5,518 | $9.2x10^{-8}$ | 10,161 | $1.7x10^{-8}$ | 15,967 | $1.6x10^{-9}$ | 11,541 | $1.1x10^{-8}$ | 14,689 | $1.0x10^{-8}$ | $2.4x10^{-6}$ | $8.8x10^{-6}$ |
| S. | 5,572 | $1.2x10^{-7}$ | 9,887 | $5.3x10^{-8}$ | 15,538 | $5.2x10^{-9}$ | 11,539 | $3.5x10^{-8}$ | 14,635 | $3.1x10^{-8}$ | $2.2x10^{-6}$ | $8.7x10^{-6}$ |
| SSW. | 17,066 | $3.7x10^{-8}$ | 10,022 | $7.5x10^{-8}$ | 15,754 | $1.0x10^{-8}$ | 11,938 | $4.8x10^{-8}$ | 15,029 | $4.3x10^{-8}$ | $2.0x10^{-6}$ | $8.0x10^{-6}$ |
| SW. | 19,889 | $3.1x10^{-8}$ | 11,654 | $6.4x10^{-8}$ | 18,300 | $1.2x10^{-8}$ | 13,874 | $4.2x10^{-8}$ | 17,460 | $3.7x10^{-8}$ | $4.4x10^{-7}$ | $6.2x10^{-6}$ |
| WSW. | 28,928 | $1.7x10^{-8}$ | 16,968 | $1.5x10^{-8}$ | 18,987 | $3.3x10^{-9}$ | 20,229 | $1.0x10^{-8}$ | 25,441 | $8.9x10^{-9}$ | $9.3x10^{-7}$ | $4.1x10^{-6}$ |
| W. | 35,299 | $9.6x10^{-9}$ | 20,727 | $1.6x10^{-8}$ | 17,013 | $5.2x10^{-9}$ | 26,938 | $9.4x10^{-9}$ | 24,305 | $1.3x10^{-8}$ | $1.1x10^{-6}$ | $5.2x10^{-6}$ |
| WNW. | 32,525 | $8.3x10^{-9}$ | 19,193 | $5.2x10^{-9}$ | 12,186 | $2.2x10^{-9}$ | 21,125 | $3.9x10^{-9}$ | 17,918 | $5.7x10^{-9}$ | $7.7x10^{-7}$ | $6.0x10^{-6}$ |
| NW. | 27,828 | $1.0x10^{-8}$ | 17,202 | $9.7x10^{-9}$ | 11,503 | $2.9x10^{-9}$ | 20,319 | $6.4x10^{-9}$ | 17,909 | $9.2x10^{-9}$ | $1.5x10^{-6}$ | $7.7x10^{-6}$ |
| NNW. | 31,168 | $1.3x10^{-8}$ | 17,397 | $1.0x10^{-8}$ | 12,205 | $3.4x10^{-9}$ | 23,854 | $5.7x10^{-9}$ | 20,732 | $8.2x10^{-9}$ | $1.2x10^{-6}$ | $5.3x10^{-6}$ |

[a] See figure 4.2.2.1–2 for location of release points.
Source: HNUS 1995a.

TABLE E.2.4–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at Idaho National Engineering Laboratory Site Boundary*

| | Direction | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| **Release Point: Central Facilities Area** | | | | |
| | SSW. | 10,021 | Central Facilities Area | $7.5 \times 10^{-8}$ |
| | SW. | 15,469 | Test Reactor Area | $4.3 \times 10^{-8}$ |
| | SSE. | 10,776 | Waste Experimental Reduction Facility/Power Burst Facility | $1.5 \times 10^{-8}$ |
| | ESE. | 22,147 | Argonne National Laboratory-West | $8.0 \times 10^{-9}$ |
| | SSE. | 10,329 | Tritium Supply Site | $1.6 \times 10^{-8}$ |
| **Release Point: Test Reactor Area** | | | | |
| | S. | 15,549 | Central Facilities Area | $5.2 \times 10^{-9}$ |
| | SW. | 18,300 | Test Reactor Area | $1.2 \times 10^{-8}$ |
| | SSE. | 16,849 | Waste Experimental Reduction Facility/Power Burst Facility | $1.5 \times 10^{-9}$ |
| | SE. | 26,967 | Argonne National Laboratory-West | $7.4 \times 10^{-10}$ |
| | SSE. | 16,392 | Tritium Supply Site | $1.5 \times 10^{-9}$ |
| **Release Point: WERF/PBF** | | | | |
| | SW. | 14,170 | Central Facilities Area | $4.1 \times 10^{-8}$ |
| | WSW. | 21,628 | Test Reactor Area | $9.2 \times 10^{-9}$ |
| | SSW. | 11,938 | Waste Experimental Reduction Facility/Power Burst Facility | $4.8 \times 10^{-8}$ |
| | SE. | 17,963 | Argonne National Laboratory-West | $4.4 \times 10^{-9}$ |
| | SSW. | 12,217 | Tritium Supply Site | $4.7 \times 10^{-8}$ |
| **Release Point: ANL-West/EBR-II** | | | | |
| | WSW. | 29,538 | Central Facilities Area | $1.7 \times 10^{-8}$ |
| | WSW. | 38,409 | Test Reactor Area | $1.2 \times 10^{-8}$ |
| | SW. | 24,904 | Waste Experimental Reduction Facility/Power Burst Facility | $2.3 \times 10^{-8}$ |
| | SSW. | 17,066 | Argonne National Laboratory-West | $3.7 \times 10^{-8}$ |
| | SW. | 25,872 | Tritium Supply Site | $2.2 \times 10^{-8}$ |
| **Release Point: Tritium Supply Site** | | | | |
| | SSW. | 16,430 | Central Facilities Area | $3.8 \times 10^{-8}$ |
| | SW. | 22,813 | Test Reactor Area | $2.6 \times 10^{-8}$ |
| | S. | 14,873 | Waste Experimental Reduction Facility/Power Burst Facility | $3.0 \times 10^{-8}$ |
| | SE. | 20,645 | Argonne National Laboratory-West | $4.4 \times 10^{-9}$ |
| | SSW. | 15,029 | Tritium Supply Site | $4.3 \times 10^{-8}$ |

Note: WERF/PBF - Waste Experimental Reduction Facility/Power Burst Facility; ANL-W/EBR-II Argonne National Laboratory-West/Experimental Breeder Reactor-II.

Source: HNUS 1995a.

**TABLE E.2.4.1–1.—*Annual Atmospheric Radioactive Releases from Normal Operation of No Action at Idaho National Engineering Laboratory (curies)***

| Isotope | Argonne National Laboratory-West | Central Facilities Area | Test Reactor Area[a] | Waste Experimental Reduction Facility/ Power Burst Facility |
|---|---|---|---|---|
| H-3 | 2.3 | 0.0 | 0.0 | 0.0 |
| Na-24 | 0.0 | 0.0 | $3.2x10^{-3}$ | 0.0 |
| Cr-51 | 0.0 | 0.0 | $5.1x10^{-3}$ | 0.0 |
| Mn-54 | 0.0 | 0.0 | $2.4x10^{-6}$ | 0.0 |
| Co-58 | 0.0 | 0.0 | $2.4x10^{-6}$ | 0.0 |
| Co-60 | 0.0 | $1.3x10^{-6}$ | $4.6x10^{-5}$ | $2.1x10^{-8}$ |
| Rb-88 | 0.0 | 0.0 | 0.50 | 0.0 |
| Rb-89 | 0.0 | 0.0 | 0.73 | 0.0 |
| Sr-90 | $3.0x10^{-5}$ | $3.7x10^{-6}$ | $4.1x10^{-4}$ | $1.6x10^{-6}$ |
| Y-91m | 0.0 | 0.0 | $7.1x10^{-4}$ | 0.0 |
| Tc-99m | 0.0 | 0.0 | $2.6x10^{-3}$ | 0.0 |
| Mo-99 | 0.0 | 0.0 | $5.3x10^{-6}$ | 0.0 |
| I-131 | $2.2x10^{-4}$ | 0.0 | $8.3x10^{-4}$ | $4.1x10^{-6}$ |
| I-132 | $9.1x10^{-4}$ | 0.0 | $1.2x10^{-3}$ | 0.0 |
| I-133 | $3.7x10^{-4}$ | 0.0 | $6.3x10^{-4}$ | 0.0 |
| I-134 | 0.0 | 0.0 | $1.1x10^{-3}$ | 0.0 |
| Cs-134 | 0.0 | 0.0 | $9.6x10^{-7}$ | 0.0 |
| Cs-137 | 0.0 | $6.3x10^{-8}$ | $3.2x10^{-6}$ | $1.8x10^{-7}$ |
| Cs-138 | 0.0 | 0.0 | 0.71 | 0.0 |
| Ba-139 | 0.0 | 0.0 | 0.051 | 0.0 |
| Ba-140 | $2.3x10^{-3}$ | 0.0 | $9.4x10^{-6}$ | 0.0 |
| La-140 | 0.0 | 0.0 | $1.4x10^{-5}$ | 0.0 |
| Hg-203 | 0.0 | 0.0 | $3.6x10^{-4}$ | 0.0 |
| Os-191 | 0.0 | 0.0 | $6.6x10^{-4}$ | 0.0 |
| Pu-239 | $8.0x10^{-6}$ | $9.6x10^{-7}$ | $7.4x10^{-7}$ | $1.3x10^{-7}$ |
| Ar-41 | 57 | 0.0 | $3.2x10^{3}$ | 0.0 |
| Kr-85 | 0.18 | 0.0 | 0.0 | 0.0 |
| Kr-85m | 21 | 0.0 | 22 | 0.0 |
| Kr-87 | 24 | 0.0 | 68 | 0.0 |
| Kr-88 | 24 | 0.0 | 66 | 0.0 |
| Xe-131m | 0.10 | 0.0 | 0.0 | 0.0 |
| Xe-133 | 450 | 0.0 | 25 | 0.0 |
| Xe-133m | $1.8x10^{-3}$ | 0.0 | 0.0 | 0.0 |
| Xe-135 | 120 | 0.0 | 79 | 0.0 |
| Xe-135m | 5.5 | 0.0 | 40 | 0.0 |
| Xe-138 | 15 | 0.0 | 200 | 0.0 |

[a] Ignores contribution of Re-188 with $1.3x10^{-4}$ curies.
Source: INEL 1993a:5.

**TABLE E.2.4.1–2.—*Doses and Resulting Health Effect to the Maximally Exposed Individual Resulting from Normal Operation at Idaho National Engineering Laboratory***

| Alternative | Dose by Pathway (mrem per year) | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated 40-Year Fatal Cancer Risk |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | $3.1 \times 10^{-5}$ | $1.7 \times 10^{-5}$ | $5.9 \times 10^{-3}$ | $9.5 \times 10^{-6}$ | $6.0 \times 10^{-3}$ | $1.7 \times 10^{-3}$ | $1.2 \times 10^{-7}$ |
| No Action Contribution to Tritium Supply Site Maximum Receptor | $2.1 \times 10^{-5}$ | $1.7 \times 10^{-5}$ | $1.2 \times 10^{-3}$ | $2.6 \times 10^{-6}$ | $1.2 \times 10^{-3}$ | $3.5 \times 10^{-4}$ | $2.5 \times 10^{-8}$ |
| Heavy Water Reactor | 0.039 | 0.14 | $4.2 \times 10^{-4}$ | $1.8 \times 10^{-4}$ | 0.18 | 0.052 | $3.7 \times 10^{-6}$ |
| Modular High Temperature Gas-Cooled Reactor | $5.2 \times 10^{-3}$ | 0.071 | $1.0 \times 10^{-4}$ | $5.1 \times 10^{-5}$ | 0.077 | 0.022 | $1.5 \times 10^{-6}$ |
| Advanced Boiling Water Reactor | 0.016 | 0.24 | $3.2 \times 10^{-3}$ | $7.0 \times 10^{-4}$ | 0.25 | 0.072 | $5.1 \times 10^{-6}$ |
| CE System 80+ | 0.016 | 0.23 | $4.9 \times 10^{-4}$ | $3.2 \times 10^{-4}$ | 0.24 | 0.069 | $4.9 \times 10^{-6}$ |
| Simplified Boiling Water Reactor | 0.016 | 0.24 | $8.9 \times 10^{-4}$ | $1.7 \times 10^{-3}$ | 0.25 | 0.072 | $5.1 \times 10^{-6}$ |
| AP600 | 0.016 | 0.23 | $1.5 \times 10^{-3}$ | $4.9 \times 10^{-4}$ | 0.24 | 0.069 | $4.9 \times 10^{-6}$ |
| Full Accelerator Production of Tritium with helium-3 | $1.8 \times 10^{-4}$ | $2.5 \times 10^{-3}$ | $1.5 \times 10^{-5}$ | $6.6 \times 10^{-10}$ | $2.7 \times 10^{-3}$ | $7.7 \times 10^{-4}$ | $5.4 \times 10^{-8}$ |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | $3.6 \times 10^{-3}$ | 0.049 | $1.5 \times 10^{-5}$ | $6.6 \times 10^{-10}$ | 0.053 | 0.015 | $1.1 \times 10^{-6}$ |
| Phased Accelerator Production of Tritium | $1.8 \times 10^{-4}$ | $2.5 \times 10^{-3}$ | $7.6 \times 10^{-6}$ | $3.4 \times 10^{-10}$ | $2.7 \times 10^{-3}$ | $7.7 \times 10^{-4}$ | $5.4 \times 10^{-8}$ |
| Tritium Recycling | $7.3 \times 10^{-3}$ | 0.099 | $6.9 \times 10^{-12}$ | 0.0 | 0.11 | 0.031 | $2.2 \times 10^{-6}$ |

[a] Individual annual background radiation is equal to 350 mrem.

Source: HNUS 1995a.

**TABLE E.2.4.1–3.—*Doses and Resulting Health Effect to the Population Within 50 Miles Resulting from Normal Operation at Idaho National Engineering Laboratory***

| Alternative | Dose by Pathway in 2030 (person-rem) | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | $4.1 \times 10^{-4}$ | $8.0 \times 10^{-3}$ | 0.029 | $4.6 \times 10^{-5}$ | 0.037 | $7.0 \times 10^{-5}$ | $7.4 \times 10^{-4}$ |
| Heavy Water Reactor | 0.33 | 31 | $1.8 \times 10^{-3}$ | $1.5 \times 10^{-3}$ | 31 | 0.058 | 0.62 |
| Modular High Temperature Gas-Cooled Reactor | 0.044 | 15 | $4.1 \times 10^{-4}$ | $3.3 \times 10^{-4}$ | 15 | 0.027 | 0.29 |
| Advanced Boiling Water Reactor | 0.13 | 51 | 0.011 | $4.8 \times 10^{-3}$ | 51 | 0.096 | 1.0 |
| CE System 80+ | 0.13 | 49 | $2.5 \times 10^{-3}$ | $2.7 \times 10^{-3}$ | 49 | 0.092 | 0.98 |
| Simplified Boiling Water Reactor | 0.13 | 49 | $3.6 \times 10^{-3}$ | 0.014 | 49 | 0.092 | 0.98 |
| AP600 | 0.13 | 49 | $8.9 \times 10^{-3}$ | $4.1 \times 10^{-3}$ | 49 | 0.092 | 0.98 |
| Full Accelerator Production of Tritium with helium-3 | $1.5 \times 10^{-3}$ | 0.53 | $4.7 \times 10^{-5}$ | $3.7 \times 10^{-11}$ | 0.53 | $1.0 \times 10^{-3}$ | 0.011 |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | $3.6 \times 10^{-3}$ | 0.049 | $1.5 \times 10^{-5}$ | $6.6 \times 10^{-10}$ | 0.053 | 0.015 | $1.1 \times 10^{-6}$ |
| Phased Accelerator Production of Tritium | $1.5 \times 10^{-3}$ | 0.53 | $2.4 \times 10^{-5}$ | $1.9 \times 10^{-11}$ | 0.53 | $1.0 \times 10^{-3}$ | 0.011 |
| Tritium Recycling | 0.061 | 21 | $5.8 \times 10^{-11}$ | 0.0 | 22 | 0.041 | 0.44 |

[a] Dose to the population within 50 miles from background radiation in year 2030 is equal to 52,600 person-rem.
Source: HNUS 1995a.

## E.2.5 Radiological Impacts at Nevada Test Site

This section presents the radiological impacts of the tritium supply technologies and recycling facilities at NTS. Section E.2.5.1 presents the radiological releases and resulting impacts from facilities associated with No Action. Section E.2.5.2 presents the radiological releases and resulting impacts from the facilities associated with tritium supply technologies and recycling facilities.

For purposes of radiological impact modelling, NTS was divided into seven separate areas which will release radioactivity in the year 2010. All release points in each area were aggregated into a single release point. Table E.2.5–1 presents the characteristics of each of the release points including location, release height, and minimum distance and annual average dispersion to the site boundary in each of the 16 directions. In order to calculate the maximum site boundary dose, the dose from each release point to the maximum receptor associated with each of the other release points has been calculated. For example, the dose resulting from releases for Areas 5, 6, 12, 19, 23, and the proposed TSS has been determined from the maximum receptor for Area 3. Figure E.2.5–1 illustrates the location of each maximum receptor in relation to each release point. The maximum site boundary dose is then determined by the maximum dose of each of the maximum receptors. Table E.2.5–2 presents the direction, distance, and atmospheric dispersion from each release point to each of the maximum receptors. Annual radiological releases were assumed to remain constant during the 40-year operational period.

The population and food stuffs distributions centered on each release area are provided in the *Health Risk Data* report. The joint frequency distribution used for the dose assessment was based on the meteorological measurements for the year 1990 from the Desert Rock at the 10m height and is contained in a technical report (*Health Risk Data*).

Doses given in this section are associated with one year of operation because regulatory standards are given as annual limits. The health effects presented are for the 40-year operational period.

### E.2.5.1 *No Action*

**Atmospheric Releases.** For No Action, six of the areas have radioactive releases to the atmosphere from normal operation. Table E.2.5.1–1 presents the estimated annual atmospheric radioactive releases.

**Liquid Releases.** There are no radioactive liquid releases to the offsite environment associated with No Action.

Tables E.2.5.1–2 and E.2.5.1–3, respectively, include the radiological impacts to the maximally exposed member of the public and offsite population within 50 miles. The maximally exposed individual would receive an annual dose of 0.040 mrem. An estimated fatal cancer risk of $8.1 \times 10^{-7}$ would result from 40 years of operation. The population within 50 miles would receive a dose of $8.2 \times 10^{-3}$ person-rem in year 2030 (mid-life of operation). An estimated $1.6 \times 10^{-4}$ fatal cancers could result from 40 years of operation.

**Workers Doses.** Based on measured values during the time period of 1989 to 1992 (*Twenty-Second Annual Report Radiation Exposures for DOE and DOE Contract Employees – 1989* (DOE/EH-0286P)) and subsequent yearly dose reports), the annual average dose to a badged worker at NTS was calculated to be 5 mrem. It is projected that in the year 2010 and beyond, there would be 619 badged workers involved in No Action activities at NTS (NTS 1993a:4). The annual average dose to these workers was assumed to remain at 5 mrem; the annual total dose among all these workers would then equal 3 person-rem. From 40 years of operation, an estimated fatal cancer risk of $7.8 \times 10^{-5}$ would result to the average worker and 0.048 fatal cancer could result among all workers.

### E.2.5.2 *Tritium Supply Technologies and Recycling*

For the tritium supply technologies and recycling facilities, the impacts from the No Action facilities need to be added to the impacts from the tritium supply technologies and recycling facilities to determine the impacts from total site operation. For example, to determine the radiological impact for the addition of an HWR at NTS, the doses from No Action facilities have to be summed with the HWR doses (which includes tritium target extraction) and

the tritium recycling doses. Estimated annual atmospheric radioactive releases for the tritium supply technologies and recycling facilities are given in section E.2.3. Tables E.2.5.1-2 and E.2.5.1-3 present the radiological impacts by tritium supply technology and recycling facility. There are no radioactive liquid releases to the offsite environment associated with this alternative.

The annual doses from total site operation associated with the different tritium supplies range from 0.11 to 0.36 mrem to the maximally exposed individual and from 23 to 73 person-rem to the 50-mile population in the year 2030. The health effects from 40 years of operation are included in both tables.

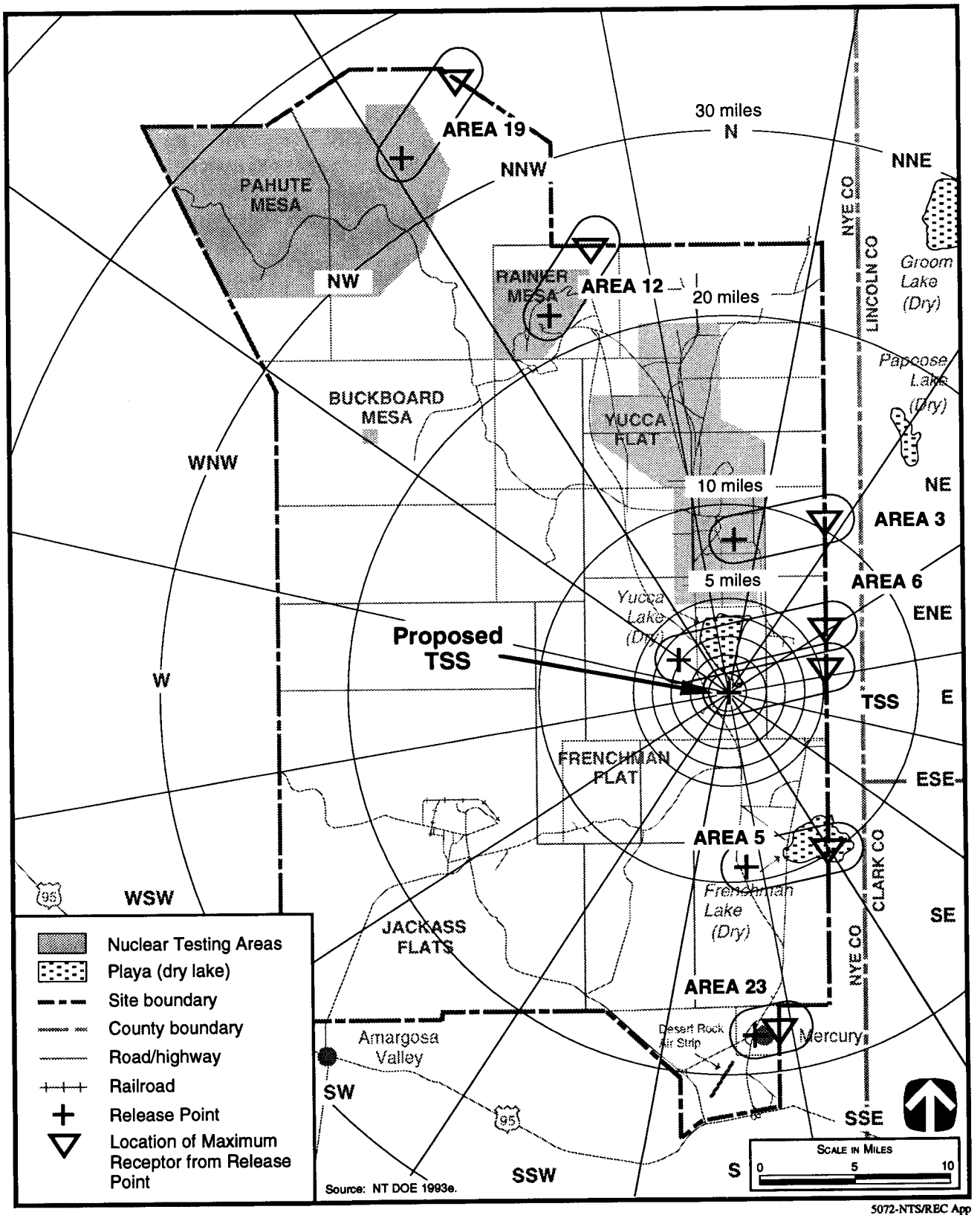



**Figure E.2.5–1.**—*Location of Maximum Receptors at Nevada Test Site.*

**TABLE E.2.5–1.—*Release Point Characteristics, Direction, Distance, and Chi/Q at Nevada Test Site Boundary* [Page 1 of 2]**

| Release Point[a] | Area 3 | | Area 5 | | Area 6 | | Area 12 | |
|---|---|---|---|---|---|---|---|---|
| Latitude | 37°1'36.12" | | 36°46'47.64" | | 36°56'816" | | 37°11'48.48" | |
| Longitude | -116°0'39.25" | | -116°0'10.08" | | -116°4'623" | | -116°11'10.69" | |
| Release Height: | Ground Level | | Ground Level | | Ground Level | | Ground Level | |
| Direction | Distance (m) | Chi/Q (sec/m$^3$) | Distance (m) | Chi/Q (sec/m$^3$) | Distance (m) | Chi/Q (sec/m$^3$) | Distance (m) | Chi/Q (sec/m$^3$) |
| N. | 24,166 | $8.7\times10^{-9}$ | 32,405 | $5.9\times10^{-9}$ | 34,911 | $5.4\times10^{-9}$ | 5,451 | $6.5\times10^{-8}$ |
| NNE. | 13,134 | $2.1\times10^{-8}$ | 11,810 | $2.5\times10^{-8}$ | 22,182 | $1.1\times10^{-8}$ | 5,569 | $6.9\times10^{-8}$ |
| NE. | 8,858 | $4.8\times10^{-8}$ | 7,952 | $5.6\times10^{-8}$ | 14,928 | $2.4\times10^{-8}$ | 6,606 | $7.3\times10^{-8}$ |
| ENE. | 7,522 | $5.3\times10^{-8}$ | 6,753 | $6.1\times10^{-8}$ | 12,727 | $2.6\times10^{-8}$ | 9,858 | $3.7\times10^{-8}$ |
| E. | 7,392 | $5.2\times10^{-8}$ | 6,632 | $6.0\times10^{-8}$ | 12,500 | $2.5\times10^{-8}$ | 22,944 | $1.1\times10^{-8}$ |
| ESE. | 7,562 | $4.2\times10^{-8}$ | 6,783 | $4.9\times10^{-8}$ | 12,775 | $2.0\times10^{-8}$ | 23,454 | $9.1\times10^{-9}$ |
| SE. | 8,969 | $3.1\times10^{-8}$ | 8,078 | $3.5\times10^{-8}$ | 15,148 | $1.5\times10^{-8}$ | 27,813 | $6.7\times10^{-9}$ |
| SSE. | 13,549 | $1.9\times10^{-8}$ | 12,243 | $2.2\times10^{-8}$ | 22,834 | $9.7\times10^{-9}$ | 42,052 | $4.4\times10^{-9}$ |
| S. | 39,154 | $6.0\times10^{-9}$ | 12,279 | $2.8\times10^{-8}$ | 30,398 | $8.4\times10^{-9}$ | 58,365 | $3.6\times10^{-9}$ |
| SSW. | 41,092 | $6.2\times10^{-9}$ | 17,496 | $1.9\times10^{-8}$ | 30,294 | $9.2\times10^{-9}$ | 40,688 | $6.3\times10^{-9}$ |
| SW. | 46,379 | $6.6\times10^{-9}$ | 17,352 | $2.4\times10^{-8}$ | 36,377 | $9.0\times10^{-9}$ | 27,188 | $1.3\times10^{-8}$ |
| WSW. | 39,124 | $5.7\times10^{-9}$ | 22,735 | $1.2\times10^{-8}$ | 34,550 | $6.8\times10^{-9}$ | 23,618 | $1.1\times10^{-8}$ |
| W. | 38,373 | $8.3\times10^{-9}$ | 39,856 | $7.9\times10^{-9}$ | 33,894 | $9.8\times10^{-9}$ | 24,146 | $1.5\times10^{-8}$ |
| WNW. | 39,139 | $8.4\times10^{-9}$ | 40,669 | $7.9\times10^{-9}$ | 34,562 | $9.8\times10^{-9}$ | 27,927 | $1.3\times10^{-8}$ |
| NW. | 46,438 | $3.8\times10^{-9}$ | 48,027 | $3.7\times10^{-9}$ | 40,791 | $4.5\times10^{-9}$ | 23,860 | $9.0\times10^{-9}$ |
| NNW. | 24,654 | $3.8\times10^{-9}$ | 53,210 | $1.4\times10^{-9}$ | 35,691 | $2.4\times10^{-9}$ | 16,125 | $6.7\times10^{-9}$ |

**TABLE E.2.5–1.—*Release Point Characteristics, Direction, Distance, and Chi/Q at Nevada Test Site Boundary* [Page 2 of 2]**

| Release Point[a] | Area 19 | | Area 23 | | Tritium Supply and Recycling Site | | | |
|---|---|---|---|---|---|---|---|---|
| Latitude | 37°18'51.84" | | 36°39'13.33" | | 36°53'42.36" | | | |
| Longitude | -116°19'20.29" | | -115°59'52.45" | | -116°2'54.96" | | | |
| Release Height: | Ground Level | | Ground Level | | 10 meters | | | |
| | | | | | | | Accident | |
| Direction | Distance (m) | Chi/Q (sec/m$^3$) | Distance (m) | Chi/Q (sec/m$^3$) | Distance (m) | Annual Average Chi/Q (sec/m$^3$) | 50 Percentile Chi/Q (sec/m$^3$) | 95 Percentile Chi/Q (sec/m$^3$) |
| N. | 6,883 | $4.7\times10^{-8}$ | 30,320 | $6.5\times10^{-9}$ | 37260. | $5.0\times10^{-9}$ | $2.5\times10^{-8}$ | $3.9\times10^{-6}$ |
| NNE. | 7,027 | $5.0\times10^{-8}$ | 11,023 | $2.7\times10^{-8}$ | 14516. | $1.9\times10^{-8}$ | $4.5\times10^{-8}$ | $9.0\times10^{-6}$ |
| NE. | 7,397 | $6.2\times10^{-8}$ | 1,993 | $4.5\times10^{-7}$ | 9785. | $4.2\times10^{-8}$ | $6.9\times10^{-8}$ | $1.9\times10^{-5}$ |
| ENE. | 8,018 | $4.8\times10^{-8}$ | 1,652 | $5.2\times10^{-7}$ | 8319. | $4.6\times10^{-8}$ | $1.1\times10^{-7}$ | $2.9\times10^{-5}$ |
| E. | 10,447 | $3.2\times10^{-8}$ | 1,607 | $5.0\times10^{-7}$ | 8175. | $4.5\times10^{-8}$ | $1.7\times10^{-7}$ | $4.3\times10^{-5}$ |
| ESE. | 12,243 | $2.2\times10^{-8}$ | 1,629 | $4.1\times10^{-7}$ | 8359. | $3.7\times10^{-8}$ | $5.7\times10^{-7}$ | $4.2\times10^{-5}$ |
| SE. | 42,415 | $3.9\times10^{-9}$ | 1,899 | $3.0\times10^{-7}$ | 9922. | $2.7\times10^{-8}$ | $1.0\times10^{-6}$ | $3.4\times10^{-5}$ |
| SSE. | 64,080 | $2.5\times10^{-9}$ | 2,827 | $1.8\times10^{-7}$ | 14923. | $1.7\times10^{-8}$ | $4.7\times10^{-7}$ | $2.0\times10^{-5}$ |
| S. | 53,585 | $4.0\times10^{-9}$ | 6,501 | $6.8\times10^{-8}$ | 27173. | $9.7\times10^{-9}$ | $1.0\times10^{-7}$ | $7.2\times10^{-6}$ |
| SSW. | 20,987 | $1.5\times10^{-8}$ | 7,059 | $6.5\times10^{-8}$ | 29216. | $9.6\times10^{-9}$ | $3.1\times10^{-8}$ | $3.9\times10^{-6}$ |
| SW. | 18,429 | $2.2\times10^{-8}$ | 7,785 | $7.0\times10^{-8}$ | 33046. | $1.0\times10^{-8}$ | $3.4\times10^{-8}$ | $3.1\times10^{-6}$ |
| WSW. | 18,295 | $1.6\times10^{-8}$ | 7,558 | $5.3\times10^{-8}$ | 38968. | $5.8\times10^{-9}$ | $1.1\times10^{-7}$ | $2.9\times10^{-6}$ |
| W. | 12,833 | $3.6\times10^{-8}$ | 9,118 | $5.7\times10^{-8}$ | 38242. | $8.4\times10^{-9}$ | $9.9\times10^{-8}$ | $4.3\times10^{-6}$ |
| WNW. | 8,875 | $6.0\times10^{-8}$ | 41,220 | $7.8\times10^{-9}$ | 39002. | $8.4\times10^{-9}$ | $6.3\times10^{-8}$ | $4.2\times10^{-6}$ |
| NW. | 8,117 | $3.9\times10^{-8}$ | 48,728 | $3.6\times10^{-9}$ | 46033. | $3.8\times10^{-9}$ | $3.8\times10^{-8}$ | $3.7\times10^{-6}$ |
| NNW. | 7,018 | $2.1\times10^{-8}$ | 67,499 | $1.0\times10^{-9}$ | 38079. | $2.2\times10^{-9}$ | $4.5\times10^{-8}$ | $5.7\times10^{-6}$ |

[a] See figure 4.3.2.1-1 for location of release points.

Source: HNUS 1995a.

**TABLE E.2.5–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at Nevada Test Site Boundary* [Page 1 of 2]**

| | Direction | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| **Release Point: Area 3** | | | | |
| | ENE. | 7,522 | Area 3 | $5.3 \times 10^{-8}$ |
| | SSE. | 27,103 | Area 5 | $7.8 \times 10^{-9}$ |
| | SE. | 10,672 | Area 6 | $2.4 \times 10^{-8}$ |
| | NNW. | 27,004 | Area 12 | $3.4 \times 10^{-9}$ |
| | NNW. | 44,680 | Area 19 | $1.8 \times 10^{-9}$ |
| | SE. | 13,243 | Tritium Supply Site | $1.8 \times 10^{-8}$ |
| | S. | 41,158 | Area 23 | $5.6 \times 10^{-9}$ |
| **Release Point: Area 5** | | | | |
| | NNE. | 29,543 | Area 3 | $7.5 \times 10^{-9}$ |
| | ENE. | 6,752 | Area 5 | $6.1 \times 10^{-8}$ |
| | NNE. | 20,762 | Area 6 | $1.2 \times 10^{-8}$ |
| | NNW. | 53,166 | Area 12 | $1.4 \times 10^{-9}$ |
| | NNW. | 69,742 | Area 19 | $1.0 \times 10^{-9}$ |
| | NNE. | 17,680 | Tritium Supply Site | $1.4 \times 10^{-8}$ |
| | S. | 13,841 | Area 23 | $2.4 \times 10^{-8}$ |
| **Release Point: Area 6** | | | | |
| | NE. | 17,000 | Area 3 | $2.0 \times 10^{-8}$ |
| | SE. | 20,273 | Area 5 | $1.0 \times 10^{-8}$ |
| | ENE. | 12,727 | Area 6 | $2.6 \times 10^{-8}$ |
| | NNW. | 35,041 | Area 12 | $2.4 \times 10^{-9}$ |
| | NNW. | 51,517 | Area 19 | $1.5 \times 10^{-9}$ |
| | E. | 12,532 | Tritium Supply Site | $2.5 \times 10^{-8}$ |
| | SSE. | 31,953 | Area 23 | $6.3 \times 10^{-9}$ |
| **Release Point: Area 12** | | | | |
| | SE. | 28,863 | Area 3 | $6.4 \times 10^{-9}$ |
| | SSE. | 50,480 | Area 5 | $3.5 \times 10^{-9}$ |
| | SE. | 35,133 | Area 6 | $4.9 \times 10^{-9}$ |
| | NE. | 6,605 | Area 12 | $7.3 \times 10^{-8}$ |
| | NNW. | 20,708 | Area 19 | $4.8 \times 10^{-9}$ |
| | SE. | 37,683 | Tritium Supply Site | $4.5 \times 10^{-9}$ |
| | SSE. | 62,700 | Area 23 | $2.6 \times 10^{-9}$ |

**TABLE E.2.5–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at Nevada Test Site Boundary* [Page 2 of 2]**

| | Direction | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| **Release Point: Area 19** | | | | |
| | SE. | 46,455 | Area 3 | $3.4 \times 10^{-9}$ |
| | SSE. | 67,757 | Area 5 | $2.4 \times 10^{-9}$ |
| | SE. | 52,890 | Area 6 | $2.9 \times 10^{-9}$ |
| | ESE. | 17,575 | Area 12 | $1.3 \times 10^{-8}$ |
| | NE. | 7,396 | Area 19 | $6.2 \times 10^{-8}$ |
| | SE. | 55,398 | Tritium Supply Site | $2.8 \times 10^{-9}$ |
| | SSE. | 79,095 | Area 23 | $1.9 \times 10^{-9}$ |
| **Release Point: Tritium Supply Site** | | | | |
| | NNE. | 16,170 | Area 3 | $1.6 \times 10^{-8}$ |
| | SSE. | 15,807 | Area 5 | $1.6 \times 10^{-8}$ |
| | ENE. | 9,495 | Area 6 | $3.8 \times 10^{-8}$ |
| | NNW. | 38,441 | Area 12 | $2.2 \times 10^{-9}$ |
| | NNW. | 55,421 | Area 19 | $1.4 \times 10^{-9}$ |
| | ENE. | 8,319 | Tritium Supply Site | $4.6 \times 10^{-8}$ |
| | S. | 28,747 | Area 23 | $9.0 \times 10^{-9}$ |
| **Release Point: Area 23** | | | | |
| | N. | 43,225 | Area 3 | $4.1 \times 10^{-9}$ |
| | NNE. | 16,488 | Area 5 | $1.6 \times 10^{-8}$ |
| | N. | 34,229 | Area 6 | $5.5 \times 10^{-9}$ |
| | NNW. | 66,933 | Area 12 | $1.1 \times 10^{-9}$ |
| | NNW. | 83,144 | Area 19 | $8.1 \times 10^{-10}$ |
| | N. | 31,002 | Tritium Supply Site | $6.3 \times 10^{-9}$ |
| | ENE. | 1,651 | Area 23 | $5.2 \times 10^{-7}$ |

Source: HNUS 1995a.

**TABLE E.2.5.1–1.—*Annual Atmospheric Radioactive Releases from Normal Operation of No Action at Nevada Test Site (curies)***

| Isotope | Area 3 | Area 5 | Area 6 | Area 12 | Area 19 | Area 23 |
|---|---|---|---|---|---|---|
| H-3 | 0.0 | 0.60 | $4.8 \times 10^{-3}$ | $2.2 \times 10^{3}$ | 0.0 | $5.1 \times 10^{-4}$ |
| Ar-37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ar-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Kr-85 | 0.0 | 0.0 | 0.0 | 0.0 | 280 | 0.0 |
| Xe-127 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Xe-129 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Xe-131 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Xe-133 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.040 |
| I-131 | 0.0 | 0.0 | $1.3 \times 10^{-5}$ | 0.0 | 0.0 | $5.8 \times 10^{-5}$ |
| Pu-239 | $2.5 \times 10^{-3}$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| U-234 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| U-235 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| U-238 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Note: For reconfiguration, Device Assembly Facility upgrade assumed to be equivalent to the assembly, disassembly and high explosion upgrade at Pantex.

Source: NTS 1993a:4; table E.2.7–2.

**TABLE E.2.5.1–2.—*Doses and Resulting Health Effect to the Maximally Exposed Individual Resulting from Normal Operation at Nevada Test Site***

| Alternative | Dose by Pathway (mrem per year) | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated 40-Year Fatal Cancer Risk |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | $3.2 \times 10^{-3}$ | 0.038 | $1.5 \times 10^{-6}$ | $1.1 \times 10^{-9}$ | 0.040 | 0.013 | $8.1 \times 10^{-7}$ |
| No Action Contribution to Tritium Supply Site Maximum Receptor | $2.8 \times 10^{-3}$ | $2.3 \times 10^{-3}$ | $3.0 \times 10^{-7}$ | $8.0 \times 10^{-9}$ | $5.1 \times 10^{-3}$ | $1.6 \times 10^{-3}$ | $1.0 \times 10^{-7}$ |
| Heavy Water Reactor | 0.039 | 0.14 | $4.8 \times 10^{-4}$ | $1.8 \times 10^{-4}$ | 0.19 | 0.059 | $3.7 \times 10^{-6}$ |
| Modular High Temperature Gas-Cooled Reactor | $5.5 \times 10^{-3}$ | 0.075 | $1.2 \times 10^{-4}$ | $5.6 \times 10^{-5}$ | 0.081 | 0.026 | $1.6 \times 10^{-6}$ |
| Advanced Boiling Water Reactor | 0.017 | 0.25 | $5.1 \times 10^{-3}$ | $8.0 \times 10^{-4}$ | 0.28 | 0.087 | $5.5 \times 10^{-6}$ |
| CE System 80+ | 0.017 | 0.24 | $6.0 \times 10^{-4}$ | $3.4 \times 10^{-4}$ | 0.27 | 0.084 | $5.3 \times 10^{-6}$ |
| Simplified Boiling Water Reactor | 0.017 | 0.25 | $1.3 \times 10^{-3}$ | $1.9 \times 10^{-3}$ | 0.28 | 0.087 | $5.5 \times 10^{-6}$ |
| AP600 | 0.017 | 0.24 | $1.7 \times 10^{-3}$ | $5.2 \times 10^{-4}$ | 0.27 | 0.084 | $5.3 \times 10^{-6}$ |
| Full Accelerator Production of Tritium with helium-3 | $2.0 \times 10^{-4}$ | $2.7 \times 10^{-3}$ | $1.4 \times 10^{-5}$ | $7.0 \times 10^{-9}$ | $2.9 \times 10^{-3}$ | $9.2 \times 10^{-4}$ | $5.8 \times 10^{-8}$ |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | $3.9 \times 10^{-3}$ | 0.053 | $1.4 \times 10^{-5}$ | $7.0 \times 10^{-9}$ | 0.057 | 0.018 | $1.1 \times 10^{-6}$ |
| Phased Accelerator Production of Tritium | $2.0 \times 10^{-4}$ | $2.7 \times 10^{-3}$ | $7.2 \times 10^{-6}$ | $3.6 \times 10^{-9}$ | $2.9 \times 10^{-3}$ | $9.2 \times 10^{-4}$ | $5.8 \times 10^{-8}$ |
| Tritium Recycling | $7.9 \times 10^{-3}$ | 0.11 | $7.2 \times 10^{-12}$ | 0.0 | 0.12 | 0.038 | $2.4 \times 10^{-6}$ |

[a] Individual annual background radiation dose is equal to 323 mrem.

Source: HNUS 1995a.

**TABLE E.2.5.1–3.—*Doses and Resulting Health Effect to the Population Within 50 Miles Resulting from Normal Operation of Nevada Test Site***

| Alternative | Dose by Pathway in 2030 (person-rem) | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | $4.3 \times 10^{-3}$ | $3.9 \times 10^{-3}$ | $1.1 \times 10^{-5}$ | $5.5 \times 10^{-9}$ | $8.2 \times 10^{-3}$ | $1.4 \times 10^{-4}$ | $1.6 \times 10^{-4}$ |
| Heavy Water Reactor | 0.035 | 0.083 | $2.4 \times 10^{-4}$ | $1.7 \times 10^{-4}$ | 0.12 | $2.0 \times 10^{-3}$ | $2.4 \times 10^{-3}$ |
| Modular High Temperature Gas-Cooled Reactor | $4.9 \times 10^{-3}$ | 0.045 | $5.8 \times 10^{-5}$ | $3.9 \times 10^{-5}$ | 0.051 | $8.7 \times 10^{-4}$ | $1.0 \times 10^{-3}$ |
| Advanced Boiling Water Reactor | 0.014 | 0.15 | $1.4 \times 10^{-3}$ | $5.5 \times 10^{-4}$ | 0.16 | $2.8 \times 10^{-3}$ | $3.3 \times 10^{-3}$ |
| CE System 80+ | 0.014 | 0.14 | $3.2 \times 10^{-4}$ | $3.0 \times 10^{-4}$ | 0.16 | $2.6 \times 10^{-3}$ | $3.1 \times 10^{-3}$ |
| Simplified Boiling Water Reactor | 0.014 | 0.16 | $4.6 \times 10^{-4}$ | $1.6 \times 10^{-3}$ | 0.17 | $3.0 \times 10^{-3}$ | $3.5 \times 10^{-3}$ |
| AP600 | 0.014 | 0.15 | $1.1 \times 10^{-3}$ | $4.5 \times 10^{-4}$ | 0.16 | $2.8 \times 10^{-3}$ | $3.3 \times 10^{-3}$ |
| Full Accelerator Production of Tritium with SILC | $3.4 \times 10^{-3}$ | 0.031 | $7.1 \times 10^{-6}$ | $6.7 \times 10^{-13}$ | 0.035 | $6.0 \times 10^{-4}$ | $7.0 \times 10^{-4}$ |
| Full Accelerator Production of Tritium with helium-3 | $1.7 \times 10^{-4}$ | $1.6 \times 10^{-3}$ | $7.6 \times 10^{-6}$ | $6.7 \times 10^{-13}$ | $1.8 \times 10^{-3}$ | $3.1 \times 10^{-5}$ | $3.6 \times 10^{-5}$ |
| Phased Accelerator Production of Tritium | $1.7 \times 10^{-4}$ | $1.6 \times 10^{-3}$ | $3.6 \times 10^{-6}$ | $3.4 \times 10^{-13}$ | $1.8 \times 10^{-3}$ | $3.1 \times 10^{-5}$ | $3.6 \times 10^{-5}$ |
| Tritium Recycling | $6.9 \times 10^{-3}$ | 0.063 | $6.4 \times 10^{-12}$ | 0.0 | 0.070 | $1.2 \times 10^{-3}$ | $1.4 \times 10^{-3}$ |

[a] Dose to the population within 50 miles from background radiation in year 2030 is equal to 5,770 person-rem.

HNUS 1995a.

## E.2.6 Radiological Impacts at Oak Ridge Reservation

This section presents the radiological impacts of the tritium supply technologies and recycling facilities at ORR. Section E.2.6.1 presents the radiological releases and resulting impacts from facilities associated with No Action. Section E.2.6.2 presents the radiological releases and resulting impacts from the facilities associated with the tritium supply technologies and recycling facilities.

For purposes of radiological impact modelling, ORR was divided into six separate areas. All potential release points in each area were aggregated into a single release point. Table E.2.6–1 presents the characteristics of each of the release points including location, release height, and minimum distance and annual average dispersion to the site boundary in each of 16 directions. In order to calculate the maximum site boundary dose, the dose from each release point to the maximum receptor associated with each of the other release points has been calculated. For example, the dose resulting from releases from the Oak Ridge National Laboratory, Y-12 Plant, Advanced Neutron Source Reactor, High Flux Isotope Reactor Areas and the proposed TSS has been determined for the maximum receptor from the K-25 incinerator. Figure E.2.6–1 illustrates the location of each maximum receptor in relation to each release point. The maximum site boundary dose is then determined by the maximum dose of each of the maximum receptors. Table E.2.6–2 presents the distance, direction and atmospheric dispersion from each release point to each of the maximum receptors. Annual radiological releases were assumed to remain constant during the 40-year operation period.

Descriptions of population, food stuffs distributions, and aquatic foods for each release area are provided in the *Health Risk Data* report. The joint frequency distributions used for the dose assessment were based on the meteorological measurements for the year 1990 from five meteorological towers (Tower 1 for K-25, Tower 2 for Oak Ridge National Laboratory, Tower 4 for Advanced Neutron Source Reactor, Tower 5 for Y-12, and Tower 6 for Radiochemical Engineering Development Center) at the 10 m height and are contained in a technical report (*Health Risk Data*).

Doses given in this section are associated with one year of operations because regulatory standards are given as annual limits. The health effects presented are for a 40-year operational period.

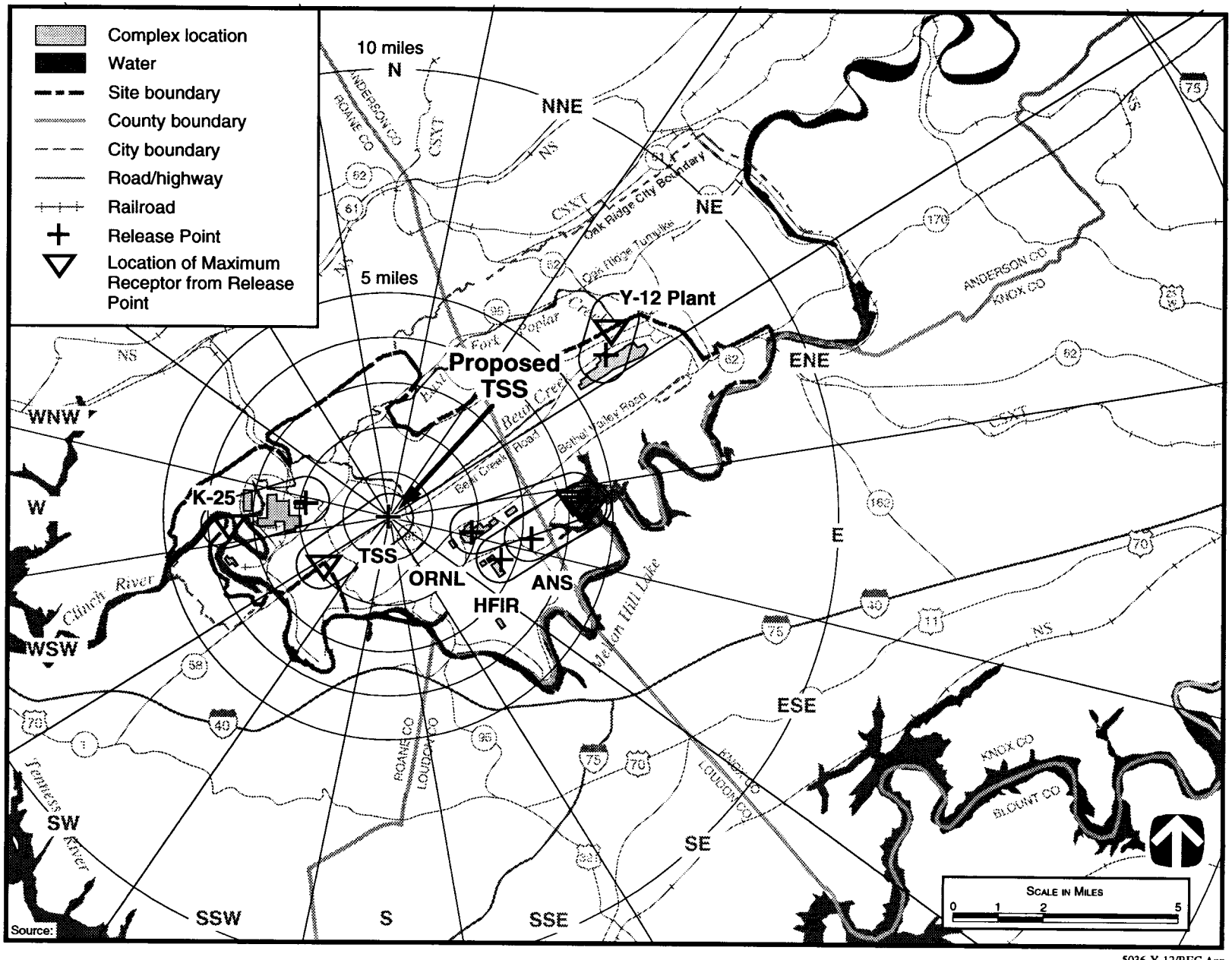
### E.2.6.1 *No Action*

**Atmospheric Releases.** For No Action, five of the areas have radioactive releases to the atmosphere from normal operation. Table E.2.6.1–1 presents the estimated annual atmospheric radioactive releases.

Tables E.2.6.1–2 and E.2.6.1–3 include the atmospheric radiological impacts to the maximally exposed member of the public and the offsite population within 50 miles, respectively. The maximally exposed individual would receive an annual dose of 3.9 mrem. An estimated fatal cancer risk of $7.8 \times 10^{-5}$ would result from 40 years of operation. The population within 50 miles would receive a dose of 39 person-rem in the year 2030 (midlife of operation). An estimated 0.78 fatal cancers could result from 40 years of operation.

**Liquid Releases.** For No Action, some areas may have radioactive releases to the offsite surface water from normal operation. Table E.2.6.1–4 presents the estimated annual liquid radioactive releases.

Tables E.2.6.1–5 and E.2.6.1–6, respectively, present the radiological impacts to the maximally exposed individual and the offsite populations using surface water within 50 miles downstream of ORR. The maximally exposed member of the public would receive an annual dose of 14 mrem. An estimated fatal cancer risk of $2.7 \times 10^{-4}$ would result from 40 years of operation. The population would receive a dose of 18 person-rem in the year 2030. An estimated 0.36 fatal cancers could result from 40 years of operation.




5036-Y-12/REC App

FIGURE E.2.6–1.—*Location of Maximum Receptors at Oak Ridge Reservation.*

**TABLE E.2.6–1.—*Release Point Characteristics, Direction, Distance, and Chi/Q at Oak Ridge Reservation Boundary* [Page 1 of 2]**

| Release Point[a] | K-25 Incinerator | | ORNL (3039 Stack) | | Y-12 Plant | | REDC | |
|---|---|---|---|---|---|---|---|---|
| **Latitude** | 35°56'15.36" | | 35°55'39.01" | | 35°59'08.52" | | 35°55'08.04" | |
| **Longitude** | -84°22'54.83" | | -84°18'55.44" | | -84°15'38.51" | | -84°18'12.95" | |
| **Release Height:** | 30.5 meters | | 76.2 meters | | 20.0 meters | | 76.2 meters | |
| **Direction** | **Distance (meter)** | **Chi/Q (sec/m$^3$)** | **Distance (meter)** | **Chi/Q (sec/m$^3$)** | **Distance (meter)** | **Chi/Q (sec/m$^3$)** | **Distance (meter)** | **Chi/Q (sec/m$^3$)** |
| N. | 3,043 | $1.3\times10^{-7}$ | 4,203 | $2.1\times10^{-8}$ | 683 | $1.1\times10^{-6}$ | 5,839 | $1.6\times10^{-8}$ |
| NNE. | 3,934 | $1.7\times10^{-7}$ | 5,845 | $2.5\times10^{-8}$ | 888 | $1.5\times10^{-6}$ | 7,329 | $3.0\times10^{-8}$ |
| NE. | 4,362 | $2.2\times10^{-7}$ | 8,512 | $2.9\times10^{-8}$ | 1,628 | $8.1\times10^{-7}$ | 3,381 | $1.3\times10^{-7}$ |
| ENE. | 4,634 | $1.6\times10^{-7}$ | 3,933 | $5.1\times10^{-8}$ | 2,336 | $4.6\times10^{-7}$ | 3,442 | $1.4\times10^{-7}$ |
| E. | 9,767 | $3.6\times10^{-8}$ | 4,326 | $3.4\times10^{-8}$ | 2,964 | $3.7\times10^{-7}$ | 3,148 | $8.5\times10^{-8}$ |
| ESE. | 9,644 | $2.9\times10^{-8}$ | 4,390 | $2.4\times10^{-8}$ | 2,283 | $1.4\times10^{-7}$ | 3,047 | $4.0\times10^{-8}$ |
| SE. | 4,924 | $7.5\times10^{-8}$ | 4,030 | $2.3\times10^{-8}$ | 2,329 | $8.1\times10^{-8}$ | 2,596 | $3.4\times10^{-8}$ |
| SSE. | 2,303 | $1.6\times10^{-7}$ | 4,377 | $2.8\times10^{-8}$ | 3,728 | $8.2\times10^{-8}$ | 2,917 | $2.1\times10^{-8}$ |
| S. | 2,421 | $1.7\times10^{-7}$ | 4,298 | $4.3\times10^{-8}$ | 4,682 | $6.1\times10^{-8}$ | 3,351 | $2.3\times10^{-8}$ |
| SSW. | 3,303 | $1.2\times10^{-7}$ | 3,752 | $5.2\times10^{-8}$ | 9,615 | $4.2\times10^{-8}$ | 3,452 | $3.3\times10^{-8}$ |
| SW. | 3,902 | $1.8\times10^{-7}$ | 3,755 | $3.4\times10^{-8}$ | 11,872 | $1.1\times10^{-7}$ | 3,626 | $9.5\times10^{-8}$ |
| WSW. | 2,895 | $2.2\times10^{-7}$ | 5,054 | $2.3\times10^{-8}$ | 3,442 | $5.3\times10^{-7}$ | 3,897 | $1.1\times10^{-7}$ |
| W. | 3,586 | $8.1\times10^{-8}$ | 8,679 | $1.1\times10^{-8}$ | 1,074 | $7.7\times10^{-7}$ | 5,926 | $3.2\times10^{-8}$ |
| WNW. | 2,783 | $7.0\times10^{-8}$ | 7,260 | $9.0\times10^{-9}$ | 806 | $5.5\times10^{-7}$ | 8,636 | $1.0\times10^{-8}$ |
| NW. | 2,356 | $9.1\times10^{-8}$ | 4,465 | $1.4\times10^{-8}$ | 686 | $6.5\times10^{-7}$ | 5,268 | $1.3\times10^{-8}$ |
| NNW. | 1,857 | $1.1\times10^{-7}$ | 3,900 | $2.0\times10^{-8}$ | 620 | $8.1\times10^{-7}$ | 5,262 | $1.2\times10^{-8}$ |

**TABLE E.2.6–1.—*Release Point Characteristics, Direction, Distance, and Chi/Q at Oak Ridge Reservation Boundary* [Page 2 of 2]**

| Release Point[a] | ANSR | | Tritium Supply and Recycling Site | | | |
|---|---|---|---|---|---|---|
| **Latitude** | 35°55'32.52" | | 35°55'59.17" | | | |
| **Longitude** | -84°17'31.20" | | -84°20'55.68" | | | |
| **Release Height:** | 10.0 meters | | Ground Level | | | |
| | | | | | **Accident** | |
| **Direction** | **Distance (meter)** | **Chi/Q (sec/m$^3$)** | **Distance (meter)** | **Annual Chi/Q (sec/m$^3$)** | **50 Percentile Chi/Q (sec/m$^3$)** | **95 Percentile Chi/Q (sec/m$^3$)** |
| N. | 5,948 | $4.3 \times 10^{-8}$ | 3,199 | $2.2 \times 10^{-7}$ | $1.8 \times 10^{-5}$ | $1.3 \times 10^{-4}$ |
| NNE. | 7,058 | $1.1 \times 10^{-7}$ | 2,993 | $5.8 \times 10^{-7}$ | $1.9 \times 10^{-5}$ | $1.7 \times 10^{-4}$ |
| NE. | 2,178 | $1.3 \times 10^{-6}$ | 4,638 | $6.2 \times 10^{-7}$ | $1.6 \times 10^{-5}$ | $8.4 \times 10^{-5}$ |
| ENE. | 2,236 | $1.4 \times 10^{-6}$ | 9,495 | $2.9 \times 10^{-7}$ | $5.8 \times 10^{-6}$ | $3.1 \times 10^{-5}$ |
| E. | 3,080 | $5.4 \times 10^{-7}$ | 6,807 | $1.5 \times 10^{-7}$ | $6.4 \times 10^{-6}$ | $3.6 \times 10^{-5}$ |
| ESE. | 2,418 | $2.9 \times 10^{-7}$ | 6,781 | $1.2 \times 10^{-7}$ | $5.8 \times 10^{-6}$ | $2.6 \times 10^{-5}$ |
| SE. | 2,413 | $1.7 \times 10^{-7}$ | 5,908 | $6.9 \times 10^{-8}$ | $7.6 \times 10^{-6}$ | $2.9 \times 10^{-5}$ |
| SSE. | 2,578 | $1.0 \times 10^{-7}$ | 3,577 | $6.0 \times 10^{-8}$ | $9.0 \times 10^{-6}$ | $3.5 \times 10^{-5}$ |
| S. | 3,161 | $9.0 \times 10^{-8}$ | 3,418 | $8.7 \times 10^{-8}$ | $1.1 \times 10^{-5}$ | $5.2 \times 10^{-5}$ |
| SSW. | 4,194 | $1.1 \times 10^{-7}$ | 3,098 | $4.5 \times 10^{-7}$ | $1.9 \times 10^{-5}$ | $1.1 \times 10^{-4}$ |
| SW. | 4,808 | $3.1 \times 10^{-7}$ | 2,903 | $1.1 \times 10^{-6}$ | $2.0 \times 10^{-5}$ | $1.5 \times 10^{-4}$ |
| WSW. | 5,104 | $4.0 \times 10^{-7}$ | 4,900 | $2.1 \times 10^{-7}$ | $9.7 \times 10^{-6}$ | $8.0 \times 10^{-5}$ |
| W. | 7,269 | $7.5 \times 10^{-8}$ | 5,700 | $5.6 \times 10^{-8}$ | $6.8 \times 10^{-6}$ | $5.7 \times 10^{-5}$ |
| WNW. | 8,983 | $2.0 \times 10^{-8}$ | 4,294 | $4.7 \times 10^{-8}$ | $6.2 \times 10^{-6}$ | $5.7 \times 10^{-5}$ |
| NW. | 5,275 | $3.1 \times 10^{-8}$ | 4,787 | $3.9 \times 10^{-8}$ | $5.1 \times 10^{-6}$ | $5.4 \times 10^{-5}$ |
| NNW. | 5,260 | $3.5 \times 10^{-8}$ | 4,770 | $4.7 \times 10^{-8}$ | $3.5 \times 10^{-6}$ | $4.1 \times 10^{-5}$ |

[a] See figure 4.4–2 for location of release points.

Note: ORNL - Oak Ridge National Laboratory; REDC - Radiochemical Engineering Development Center; ANSR - Advanced Neutron Source Reactor.

Source: HNUS 1995a.

**TABLE E.2.6–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at Oak Ridge Reservation Site Boundary***

| | Direction | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| **Release Point: K-25 Incinerator** | | | | |
| | WSW. | 2894. | K-25 Incinerator | $6.4 \times 10^{-7}$ |
| | E. | 9784 | ORNL 3039 Stack | $7.1 \times 10^{-8}$ |
| | ENE. | 12748 | Y-12 Plant | $7.8 \times 10^{-8}$ |
| | E. | 9993 | HFIR Stack | $6.9 \times 10^{-8}$ |
| | SSE. | 2307 | Tritium Supply Site | $5.3 \times 10^{-7}$ |
| | E. | 9916 | ANSR | $7.0 \times 10^{-8}$ |
| **Release Point: X-10 ORNL** | | | | |
| | W. | 8756 | K-25 Incinerator | $5.7 \times 10^{-8}$ |
| | ENE. | 3933 | ORNL 3039 Stack | $6.1 \times 10^{-7}$ |
| | NNE. | 8943 | Y-12 Plant | $9.7 \times 10^{-8}$ |
| | ENE. | 4083 | HFIR Stack | $5.7 \times 10^{-7}$ |
| | WSW. | 5407 | Tritium Supply Site | $2.3 \times 10^{-7}$ |
| | ENE. | 4023 | ANSR | $5.9 \times 10^{-7}$ |
| **Release Point: Y-12 Plant** | | | | |
| | WSW. | 15037 | K-25 Incinerator | $7.2 \times 10^{-8}$ |
| | S. | 5508 | ORNL 3039 Stack | $4.8 \times 10^{-8}$ |
| | NNE. | 887 | Y-12 Plant | $1.5 \times 10^{-6}$ |
| | S. | 5676 | HFIR Stack | $4.6 \times 10^{-8}$ |
| | SW. | 12769 | Tritium Supply Site | $9.6 \times 10^{-8}$ |
| | S. | 5625 | ANSR | $4.7 \times 10^{-8}$ |
| **Release Point: HFIR Stack** | | | | |
| | W. | 9896 | K-25 Incinerator | $4.9 \times 10^{-8}$ |
| | NE. | 3389 | ORNL 3039 Stack | $7.0 \times 10^{-7}$ |
| | NNE. | 9225 | Y-12 Plant | $8.0 \times 10^{-8}$ |
| | ENE. | 3440 | HFIR Stack | $7.5 \times 10^{-7}$ |
| | W. | 6431 | Tritium Supply Site | $9.2 \times 10^{-8}$ |
| | NE. | 3412 | ANSR | $7.0 \times 10^{-7}$ |
| **Release Point: Tritium Supply Site** | | | | |
| | W. | 5750 | K-25 Incinerator | $5.5 \times 10^{-8}$ |
| | E. | 6817 | ORNL 3039 Stack | $1.5 \times 10^{-7}$ |
| | NE. | 10558 | Y-12 Plant | $1.9 \times 10^{-7}$ |
| | E. | 7012 | HFIR Stack | $1.5 \times 10^{-7}$ |
| | SW. | 2903 | Tritium Supply Site | $1.1 \times 10^{-6}$ |
| | E. | 6939 | ANSR | $1.5 \times 10^{-7}$ |
| **Release Point: ANS Reactor** | | | | |
| | W. | 10875 | K-25 Incinerator | $4.2 \times 10^{-8}$ |
| | NE. | 2098 | ORNL 3039 Stack | $1.5 \times 10^{-6}$ |
| | NNE. | 8104 | Y-12 Plant | $9.7 \times 10^{-8}$ |
| | ENE. | 2156 | HFIR Stack | $1.6 \times 10^{-6}$ |
| | W. | 7526 | Tritium Supply Site | $7.3 \times 10^{-8}$ |
| | ENE. | 2124 | ANSR | $1.6 \times 10^{-6}$ |

Source: HNUS 1995a.

**TABLE E.2.6.1–1.—*Annual Atmospheric Radioactive Releases from Normal Operation of No Action at Oak Ridge Reservation (curies)* [Page 1 of 2]**

| Isotope | ANSR | K-25 Incinerator | ORNL | REDC[a] | Y-12 Plant |
|---|---|---|---|---|---|
| H-3 | $7.2x10^{3}$ | 0.0 | $1.6x10^{4}$ | 13 | 0.0 |
| Be-7 | 0.0 | 0.0 | $6.7x10^{-6}$ | 0.0 | 0.0 |
| Co-57 | 0.0 | $4.1x10^{-7}$ | 0.0 | 0.0 | 0.0 |
| Co-60 | $2.2x10^{-8}$ | 0.0 | $2.0x10^{-4}$ | 0.0 | 0.0 |
| Br-82 | 0.0 | 0.0 | $8.8x10^{-4}$ | 0.0 | 0.0 |
| Kr-83m | 0.0 | 0.0 | 0.0 | 1.9 | 0.0 |
| Kr-85 | $1.8x10^{3}$ | 0.0 | $4.8x10^{3}$ | 230 | 0.0 |
| Kr-85m | 0.0 | 0.0 | 0.0 | 3.8 | 0.0 |
| Kr-87 | 0.0 | 0.0 | 0.0 | 23 | 0.0 |
| Kr-88 | 0.0 | 0.0 | 0.0 | 17 | 0.0 |
| Kr-89 | 0.0 | 0.0 | 0.0 | 330 | 0.0 |
| Kr-90 | 0.0 | 0.0 | 0.0 | 700 | 0.0 |
| Rb-88 | 0.0 | 0.0 | 0.0 | 13 | 0.0 |
| Rb-89 | 0.0 | 0.0 | 0.0 | 52 | 0.0 |
| Rb-90 | 0.0 | 0.0 | 0.0 | 160 | 0.0 |
| Rb-90m | 0.0 | 0.0 | 0.0 | 15 | 0.0 |
| Sr-89 | 0.0 | 0.0 | 0.0 | 0.016 | 0.0 |
| Sr-90 | $2.2x10^{-6}$ | 0.0 | $3.3x10^{-5}$ | $5.0x10^{-5}$ | 0.0 |
| Sr-91 | 0.0 | 0.0 | 0.0 | 0.21 | 0.0 |
| Sr-92 | 0.0 | 0.0 | 0.0 | $1.0x10^{-5}$ | 0.0 |
| Y-91 | 0.0 | 0.0 | 0.0 | $7.0x10^{-4}$ | 0.0 |
| Y-92 | 0.0 | 0.0 | 0.0 | $1.0x10^{-5}$ | 0.0 |
| Zr-95 | 0.0 | 0.0 | 0.0 | $2.0x10^{-8}$ | 0.0 |
| Nb-95 | 0.0 | $1.5x10^{-6}$ | 0.0 | 0.0 | 0.0 |
| Tc-99 | 0.0 | 0.040 | 0.0 | 0.0 | 0.0 |
| Ru-103 | 0.0 | 0.0 | 0.0 | $6.0x10^{-8}$ | 0.0 |
| Ru-106 | 0.0 | 0.0 | 0.0 | $6.0x10^{-8}$ | 0.0 |
| Ag-110m | 0.0 | 0.0 | 0.0 | $1.0x10^{-9}$ | 0.0 |
| Te-132 | $1.0x10^{-5}$ | 0.0 | 0.0 | 0.0 | 0.0 |
| I-129 | $3.7x10^{-6}$ | 0.0 | $4.2x10^{-6}$ | $6.0x10^{-4}$ | 0.0 |
| I-131 | 0.13 | 0.0 | $2.1x10^{-6}$ | 0.28 | 0.0 |
| I-132 | $5.4x10^{-3}$ | 0.0 | 0.0 | $3.8x10^{-2}$ | 0.0 |
| I-133 | 0.13 | 0.0 | 0.0 | $6.6x10^{-3}$ | 0.0 |
| I-134 | 0.0 | 0.0 | 0.0 | 0.23 | 0.0 |
| I-135 | 0.11 | 0.0 | 0.0 | 0.030 | 0.0 |
| Xe-131m | 0.0 | 0.0 | 0.0 | 0.12 | 0.0 |
| Xe-133 | $8.5x10^{3}$ | 0.0 | 0.0 | 380 | 0.0 |
| Xe-133m | 0.0 | 0.0 | 0.0 | 0.23 | 0.0 |
| Xe-135 | 0.0 | 0.0 | 0.0 | 100 | 0.0 |
| Xe-135m | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Xe-137 | 0.0 | 0.0 | 0.0 | $4.0x10^{3}$ | 0.0 |
| Xe-138 | 0.0 | 0.0 | 0.0 | $1.7x10^{3}$ | 0.0 |
| Cs-134 | 0.0 | 0.0 | 0.0 | $2.0x10^{-9}$ | 0.0 |
| Cs-136 | 0.0 | 0.0 | 0.0 | $9.0x10^{-9}$ | 0.0 |
| Cs-137 | $4.4x10^{-6}$ | $5.5x10^{-4}$ | $6.9x10^{-5}$ | $1.1x10^{-3}$ | 0.0 |
| Cs-138 | 0.0 | 0.0 | 0.0 | 400 | 0.0 |

**TABLE E.2.6.1–1.—*Annual Atmospheric Radioactive Releases from Normal Operation of No Action at Oak Ridge Reservation (curies)* [Page 2 of 2]**

| Isotope | ANSR | K-25 Incinerator | ORNL | REDC[a] | Y-12 Plant |
|---|---|---|---|---|---|
| Cs-139 | 0.0 | 0.0 | 0.0 | $1.5x10^{3}$ | 0.0 |
| Ba-139 | 0.0 | 0.0 | 0.0 | 92 | 0.0 |
| Ba-140 | 0.0 | 0.0 | 0.0 | 0.22 | 0.0 |
| Ba-141 | 0.0 | 0.0 | 0.0 | $2.0x10^{-5}$ | 0.0 |
| La-140 | $3.0x10^{-6}$ | 0.0 | 0.0 | 0.0 | 0.0 |
| La-141 | 0.0 | 0.0 | 0.0 | $1.0x10^{-6}$ | 0.0 |
| Ce-141 | 0.0 | 0.0 | 0.0 | $5.0x10^{-8}$ | 0.0 |
| Ce-144 | 0.0 | 0.0 | 4.0 | $6.0x10^{-8}$ | 0.0 |
| Nd-147 | 0.0 | 0.0 | 0.0 | $2.0x10^{-8}$ | 0.0 |
| Eu-154 | 0.0 | 0.0 | 0.0 | $4.0x10^{-10}$ | 0.0 |
| Eu-155 | 0.0 | 0.0 | 0.0 | $4.0x10^{-10}$ | 0.0 |
| Eu-156 | 0.0 | 0.0 | 0.0 | $5.0x10^{-8}$ | 0.0 |
| Tb-160 | 0.0 | 0.0 | 0.0 | $8.0x10^{-10}$ | 0.0 |
| Os-191 | 0.0 | 0.0 | 4.0 | 0.0 | 0.0 |
| Pb-212 | 0.057 | 0.0 | 0.22 | 0.0 | 0.0 |
| Th-228 | $8.8x10^{-9}$ | $2.7x10^{-3}$ | $4.2x10^{-8}$ | 0.0 | 0.0 |
| Th-230 | $1.1x10^{-8}$ | $8.4x10^{-5}$ | $1.3x10^{-8}$ | 0.0 | 0.0 |
| Th-232 | $7.8x10^{-9}$ | $1.5x10^{-5}$ | $9.6x10^{-9}$ | 0.0 | 0.0 |
| Th-234 | 0.0 | 0.047 | 0.0 | 0.0 | 0.0 |
| U-234 | $1.6x10^{-8}$ | 0.011 | $5.3x10^{-8}$ | 0.0 | 0.040 |
| U-235 | 0.0 | $4.6x10^{-4}$ | 0.0 | 0.0 | $1.2x10^{-3}$ |
| U-236 | 0.0 | $4.0x10^{-11}$ | 0.0 | 0.0 | $1.6x10^{-4}$ |
| U-238 | 0.0 | 0.013 | 0.0 | 0.0 | $5.5x10^{-3}$ |
| Np-237 | 0.0 | $8.1x10^{-4}$ | 0.0 | 0.0 | 0.0 |
| Pu-238 | 0.0 | $4.3x10^{-8}$ | $7.3x10^{-8}$ | $4.0x10^{-9}$ | 0.0 |
| Pu-239 | $4.3x10^{-10}$ | $5.4x10^{-5}$ | $3.6x10^{-7}$ | $5.0x10^{-10}$ | 0.0 |
| Pu-240 | 0.0 | 0.0 | 0.0 | $9.0x10^{-10}$ | 0.0 |
| Pu-241 | 0.0 | 0.0 | 0.0 | $1.0x10^{-7}$ | 0.0 |
| Pu-242 | 0.0 | 0.0 | 0.0 | $3.0x10^{-12}$ | 0.0 |
| Cm-244 | 0.0 | 0.0 | 0.0 | $2.0x10^{-7}$ | 0.0 |
| Cf-252 | 0.0 | 0.0 | 0.0 | $1.0x10^{-8}$ | 0.0 |

[a] The following isotopes were not in GENII. To account for its activity, the isotope's activity was added to its daughter's activity adjusted by the ratio of the daughter-to-parent half-lives. Kr-91 half-life of 8.6 S decays to Rb-91 half-life 1.2 min. Rr-91 half-life of 1.2 M decays to Sr-91 half-life 9.67 hr. I-133M half-life of 9 S decays to I-133 half-life 21 hr. I-136 half-life of 1.39M decays to Xe-136 (stable). I-137 half-life of 24.5 S decays to Cs-137 half-life 30 yr. I-138 half-life of 5.9 S decays to Xe-138 half-life 17 min. Xe-139 half-life of 39.7 S decays to Cs-139 half-life 9.5 min. Xe-140 half-life of 13.6 S decays to Ba-140 half-life 12.8 day. Cs-140 half-life of 1.06 M decays to Ba-140 half-life 12.8 day. Rn-220 half-life of 55.6 S decays to Pb-208 (stable). Bk-243 half-life of 4.5 hr not in GENII. Es-253 half-life of 20.47 day not in GENII.

Note: ANSR - Advanced Neutron Source Reactor; ORNL - Oak Ridge National Laboratory; REDC - Radiochemical Engineering Development Center.

Source: ORR 1993a:8.

**Worker Doses.** Based on measured value during 1991 and 1992 (Dose Reports for 1991 and 1992) and including the contribution from the Advanced Neutron Source Reactor, it is estimated that the average dose to a badged worker involved in No Action activities at ORR in the year 2010 and beyond would equal 17.4 mrem. It is projected that in the year 2010 and beyond, there would be 18,315 badged workers involved in No Action activities. The annual dose among all these workers would equal 319 person-rem. From 40 years of operation, an estimated fatal cancer risk of $2.8 \times 10^{-4}$ would result to the average worker and 5.1 fatal cancers could result among all workers.

### E.2.6.2 *Tritium Supply Technologies and Recycling*

**Atmospheric Releases.** For the tritium supply technologies and recycling facilities, total site radiological impacts resulting from tritium supply technologies and recycling facilities can be found by adding the impacts resulting from No Action facilities to those resulting from each tritium supply technology and recycling facility. For example, to determine the radiological impact for the addition of an HWR at ORR, the No Action facilities impacts have to be summed with the HWR doses (which includes tritium target extraction) and the tritium recycling doses. Estimated annual atmospheric radioactive releases for the tritium supply technologies and recycling facilities are given in section E.2.3. Tables E.2.6.1–2 and E.2.6.1–3 present the atmospheric radiological impacts by tritium supply technology and recycling facility.

The annual doses from total site operation associated with the different tritium supplies range from 4.3 to 5.0 mrem to the maximally exposed member of the public and from 50 to 70 person-rem to the 50-mile population in the year 2030. The health effects from 40 years of operation are included in both tables.

**Liquid Releases.** There are three technologies that would release liquid discharges to the surface water surrounding ORR. These are the HWR and the Large and Small ALWRs. The liquid releases for these two technologies are given in section E.2.3. For example, to determine the liquid radiological impact for the addition of an HWR at ORR, the No Action liquid impacts must be summed with the HWR liquid doses. Tables E.2.6.1–5 and E.2.6.1–6 present the liquid radiological impacts for the applicable alternatives.

The annual doses from total site operations associated with the different tritium supplies that have liquid releases are all approximately 14 mrem to the maximally exposed member of the public, and range from 18 to 23 person-rem to the downstream population in the year 2030. The health effects from 40 years of operation are included in both tables.

**TABLE E.2.6.1–2.—*Doses and Resulting Health Effect to the Maximally Exposed Individual from Atmospheric Releases Associated with Normal Operation at Oak Ridge Reservation***

| Alternative | Dose by Pathway (mrem per year) | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated 40-Year Fatal Cancer Risk |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action – Advanced Neutron Source Reactor | 0.34 | 3.0 | 0.55 | 0.015 | 3.9 | 1.3 | $7.8 \times 10^{-5}$ |
| No Action – High Flux Isotope Reactor | 1.8 | $8.4 \times 10^{-3}$ | 0.034 | $5.3 \times 10^{-4}$ | 1.8 | 0.59 | $3.6 \times 10^{-5}$ |
| No Action Contribution to Tritium Supply Site Maximum Receptor from Advanced Neutron Source Reactor | 0.58 | 0.16 | 0.11 | $2.5 \times 10^{-3}$ | 0.85 | 0.28 | $1.7 \times 10^{-5}$ |
| No Action Contribution to Tritium Supply Site Maximum Receptor from High Flux Isotope Reactor | 0.57 | 0.017 | 0.092 | $1.3 \times 10^{-3}$ | 0.67 | 0.22 | $1.3 \times 10^{-5}$ |
| Heavy Water Reactor | 0.22 | 3.3 | 0.013 | $3.6 \times 10^{-4}$ | 3.5 | 1.1 | $7.0 \times 10^{-5}$ |
| Modular High Temperature Gas-Cooled Reactor | 0.14 | 1.9 | $3.2 \times 10^{-3}$ | $1.5 \times 10^{-3}$ | 2.0 | 0.66 | $4.0 \times 10^{-5}$ |
| AP600 Reactor | 0.13 | 2.2 | 0.043 | $3.8 \times 10^{-3}$ | 2.4 | 0.78 | $4.8 \times 10^{-5}$ |
| Advanced Boiling Water Reactor | 0.27 | 4.3 | 0.16 | 0.017 | 4.7 | 1.5 | $9.4 \times 10^{-5}$ |
| CE System 80+ | 0.33 | 4.9 | 0.015 | $3.5 \times 10^{-4}$ | 5.2 | 1.7 | $1.0 \times 10^{-4}$ |
| Simplified Boiling Water Reactor | 0.23 | 3.7 | 0.039 | 0.043 | 4.0 | 1.3 | $8.0 \times 10^{-5}$ |
| Full Accelerator Production of Tritium with helium-3 | $4.8 \times 10^{-3}$ | 0.065 | $4.2 \times 10^{-4}$ | $4.7 \times 10^{-6}$ | 1.4 | 0.46 | $2.8 \times 10^{-5}$ |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | 0.099 | 1.3 | $4.2 \times 10^{-4}$ | $4.7 \times 10^{-6}$ | 0.070 | 0.023 | $1.4 \times 10^{-6}$ |
| Phased Accelerator Production of Tritium | $4.8 \times 10^{-3}$ | 0.065 | $1.7 \times 10^{-4}$ | $2.4 \times 10^{-7}$ | 0.070 | 0.023 | $1.4 \times 10^{-6}$ |
| Tritium Recycling | 0.19 | 2.6 | $1.8 \times 10^{-6}$ | 0.0 | 2.8 | 0.92 | $5.6 \times 10^{-5}$ |

[a] Individual annual background radiation dose is equal to 306 mrem.

Source: HNUS 1995a.

**TABLE E.2.6.1–3.—*Doses and Resulting Health Effect to the Population Within 50 Miles of Oak Ridge Reservation from Atmospheric Releases Associated with Normal Operation***

| Alternative | Dose by Pathway in 2030 (person-rem) | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action – Advanced Neutron Source Reactor | 29 | 5.4 | 4.1 | 0.16 | 39 | 0.012 | 0.77 |
| No Action – High Flux Isotope Reactor | 27 | 0.23 | 3.9 | 0.055 | 31 | $9.5 \times 10^{-3}$ | 0.63 |
| AP600 Reactor | 2.1 | 7.1 | 0.52 | 0.061 | 9.8 | $3.0 \times 10^{-3}$ | 0.20 |
| Advanced Boiling Water Reactor | 4.3 | 14 | 0.84 | 0.21 | 19 | $5.6 \times 10^{-3}$ | 0.37 |
| CE System 80+ | 5.3 | 15 | 0.16 | $5.5 \times 10^{-3}$ | 21 | $6.2 \times 10^{-3}$ | 0.41 |
| Simplified Boiling Water Reactor | 3.7 | 12 | 0.25 | 0.66 | 17 | $5.0 \times 10^{-3}$ | 0.33 |
| Heavy Water Reactor | 3.4 | 10 | 0.12 | $5.6 \times 10^{-3}$ | 14 | $4.2 \times 10^{-3}$ | 0.28 |
| Modular High Temperature Gas-Cooled Reactor | 2.2 | 5.7 | 0.030 | 0.018 | 7.9 | $2.4 \times 10^{-3}$ | 0.16 |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | 1.5 | 4.0 | $4.0 \times 10^{-3}$ | $1.7 \times 10^{-7}$ | 5.5 | $1.7 \times 10^{-3}$ | 0.11 |
| Full Accelerator Production of Tritium with helium-3 | 0.077 | 0.20 | $4.0 \times 10^{-3}$ | $1.7 \times 10^{-7}$ | 0.28 | $8.6 \times 10^{-5}$ | $5.7 \times 10^{-3}$ |
| Phased Accelerator Production of Tritium | 0.077 | 0.20 | $2.0 \times 10^{-3}$ | $8.6 \times 10^{-8}$ | 0.28 | $8.6 \times 10^{-5}$ | $5.6 \times 10^{-3}$ |
| Tritium Recycling | 3.1 | 7.9 | $2.0 \times 10^{-9}$ | 0.0 | 11 | $3.3 \times 10^{-3}$ | 0.22 |

[a] Dose to the population within 50 miles from background radiation in year 2030 is equal to 325,000 person-rem.

Source: HNUS 1994a.

**TABLE E.2.6.1–4.—*Annual Liquid Releases from Normal Operation of No Action at Oak Ridge Reservation (curies)***

| Isotope | Oak Ridge National Laboratory | Y-12 Plant |
|---|---|---|
| H-3 | $2.5 \times 10^{3}$ | 0.0 |
| Co-60 | 0.17 | 0.0 |
| Sr-90 | 3.2 | $6.4 \times 10^{-3}$ |
| Tc-99 | 0.0 | $9.9 \times 10^{-5}$ |
| Cs-137 | 1.8 | 0.0 |
| Ra-226 | 0.0 | 0.032 |
| Ra-228 | 0.0 | 1.4 |
| U-234 | 0.0 | 0.11 |
| U-235 | 0.0 | $6.4 \times 10^{-3}$ |
| U-238 | 0.0 | 0.12 |
| Np-237 | 0.0 | $9.8 \times 10^{-4}$ |
| Th-228 | 0.0 | $6.3 \times 10^{-3}$ |
| Th-230 | 0.0 | $2.8 \times 10^{-3}$ |
| Th-232 | 0.0 | $4.6 \times 10^{-4}$ |
| Th-234 | 0.0 | 0.015 |
| Pu-238 | 0.0 | 0.0 |
| Pu-239 | 0.0 | $2.3 \times 10^{-4}$ |

Source: ORR 1993a:8.

**TABLE E.2.6.1–5.—*Doses and Resulting Health Effect to the Maximally Exposed Individual at Oak Ridge Reservation from Liquid Releases Associated with Normal Operation***

| Alternative | Dose by Pathway (mrem per year) | | | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated Risk of 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|---|---|
| | Fish Ingestion | Other Food Ingestion | Drinking Water | Boating | Swimming | Shoreline | | | |
| No Action – Advanced Neutron Source Reactor | 13 | 0.022 | 0.40 | $4.4 \times 10^{-5}$ | $8.8 \times 10^{-5}$ | 0.027 | 14 | 4.4 | $2.7 \times 10^{-4}$ |
| No Action – High Flux Isotope Reactor | 13 | 0.022 | 0.40 | $4.4 \times 10^{-5}$ | $8.8 \times 10^{-5}$ | 0.027 | 14 | 4.4 | $2.7 \times 10^{-4}$ |
| Heavy Water Reactor | 0.13 | $4.4 \times 10^{-3}$ | 0.019 | $1.2 \times 10^{-5}$ | $2.4 \times 10^{-5}$ | $4.8 \times 10^{-4}$ | 0.15 | 0.05 | $3.1 \times 10^{-6}$ |
| AP600 | 0.13 | 0.060 | 0.20 | $6.0 \times 10^{-6}$ | $1.2 \times 10^{-5}$ | $9.4 \times 10^{-4}$ | 0.39 | 0.13 | $7.8 \times 10^{-6}$ |
| Advanced Boiling Water Reactor | 0.041 | 0.030 | 0.098 | $2.8 \times 10^{-6}$ | $5.6 \times 10^{-6}$ | $3.3 \times 10^{-4}$ | 0.17 | 0.055 | $3.4 \times 10^{-6}$ |
| CE System 80+ | 0.10 | 0.016 | 0.051 | $5.3 \times 10^{-6}$ | $1.1 \times 10^{-5}$ | $8.5 \times 10^{-4}$ | 0.18 | 0.058 | $3.5 \times 10^{-6}$ |
| Simplified Boiling Water Reactor | 0.044 | 0.039 | 0.13 | $2.8 \times 10^{-6}$ | $5.6 \times 10^{-6}$ | $3.4 \times 10^{-4}$ | 0.21 | 0.07 | $4.3 \times 10^{-6}$ |

[a] Individual annual background radiation dose is equal to 306 mrem.
Source: HNUS 1994a.

**TABLE E.2.6.1–6.—*Doses and Resulting Health Effect to the Population Downstream of Oak Ridge Reservation from Liquid Releases Associated with Normal Operation***

| Alternative | Dose by Pathway (person-rem in 2030) | | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|---|
| | Fish Ingestion | Drinking Water | Boating | Swimming | Shoreline | | | |
| No Action – Advanced Neutron Source Reactor | 8.8 | 9.1 | $2.0 \times 10^{-3}$ | $1.7 \times 10^{-3}$ | 0.22 | 18 | $5.8 \times 10^{-3}$ | 0.36 |
| No Action – High Flux Isotope Reactor | 8.8 | 9.1 | $2.0 \times 10^{-3}$ | $1.7 \times 10^{-3}$ | 0.22 | 18 | $5.8 \times 10^{-3}$ | 0.36 |
| Heavy Water Reactor | 0.25 | 0.43 | $5.6 \times 10^{-4}$ | $4.8 \times 10^{-4}$ | $3.8 \times 10^{-3}$ | 0.69 | $2.2 \times 10^{-4}$ | 0.014 |
| AP600 | 0.31 | 4.6 | $2.8 \times 10^{-4}$ | $2.4 \times 10^{-4}$ | $7.6 \times 10^{-3}$ | 4.9 | $1.6 \times 10^{-3}$ | 0.099 |
| Advanced Boiling Water Reactor | 0.084 | 2.3 | $1.3 \times 10^{-4}$ | $1.1 \times 10^{-4}$ | $2.6 \times 10^{-3}$ | 2.4 | $7.7 \times 10^{-4}$ | 0.048 |
| CE System 80+ | 0.20 | 1.2 | $2.4 \times 10^{-4}$ | $2.1 \times 10^{-4}$ | $6.8 \times 10^{-3}$ | 1.4 | $4.5 \times 10^{-4}$ | 0.028 |
| Simplified Boiling Water Reactor | 0.089 | 3.0 | $1.3 \times 10^{-4}$ | $1.1 \times 10^{-4}$ | $2.7 \times 10^{-3}$ | 3.1 | $1.0 \times 10^{-3}$ | 0.062 |

[a] Dose to the population from background radiation in year 2030 is equal to 325,000 person-rem.

Source: HNUS 1995a.

## E.2.7 Radiological Impacts at Pantex Plant

This section presents the radiological impacts of the tritium supply technologies and recycling facilities at Pantex. Section E.2.7.1 presents the radiological releases and resulting impacts from facilities associated with No Action. Section E.2.7.2 presents the radiological releases and resulting impacts from the facilities associated with tritium supply technologies and recycling facilities.

For purposes of radiological impact modelling, Pantex was divided into four separate areas which will release radioactivity in the year 2010. All release points in each area were aggregated into a single release point. Table E.2.7–1 presents the characteristics of each of the release points including location, release height, and minimum distance and annual average dispersion to the site boundary in each of 16 directions. In order to calculate the maximum site boundary dose, the dose from each release point to the maximum receptor associated with each of the other release points has been calculated. For example, the dose resulting from releases from Building 12-44 Cell 1, and the proposed TSS has been determined from the maximum receptor from the HE Burning Grounds. Figure E.2.7–1 illustrates the location of each maximum receptor in relation to each release point. The maximum site boundary dose is then determined by the maximum dose of each of the maximum receptors. Table E.2.7–2 presents the distance, direction and atmospheric dispersion from each release point to each of the maximum receptors. Annual radiological releases were assumed to remain constant during the 40-year operational period.

Descriptions of population and food stuff distributions centered on each release area are provided in a technical report *Health Risk Data*. The joint frequency distribution used for the dose assessment was based on the meteorological measurements for the year 1989 from the National Weather Service at the 10 m height and is contained in a technical report (*Health Risk Data*).

Doses given in this section are associated with one year of operation because regulatory standards are given as annual limits. The health effects presented are for the 40-year operational period.

### E.2.7.1 *No Action*

**Atmospheric Releases.** For No Action, two of the areas have radioactive releases to the atmosphere from normal operation. Table E.2.7.1–1 presents the estimated annual atmospheric radioactive releases for No Action.

**Liquid Releases.** There are no radioactive liquid releases to the offsite environment associated with No Action.

**TABLE E.2.7.1–1.—*Annual Atmospheric Radioactive Releases from Normal Operation of No Action at Pantex Plant (curies)***

| | Weapons Assembly/ Disassembly High Explosive | | |
|---|---|---|---|
| **Isotope** | **Building 12-44, Cell 1** | **Burning Ground** | **Plutonium Storage** |
| H-3 | 0.10 | 0.0 | 0.0 |
| U-238 | 0.0 | $2.1 \times 10^{-5}$ | 0.0 |

Source: PX 1993a:2.

Tables E.2.7.1–2 and E.2.7.1–3 includes the radiological impacts to the maximally exposed individual and the offsite population within 50 miles, respectively. The maximally exposed individual would receive an annual dose of $1.3 \times 10^{-3}$ mrem. An estimated fatal cancer risk of $2.6 \times 10^{-8}$ would result from 40 years of operation. The population within 50 miles would receive a dose of $5.7 \times 10^{-4}$ person-rem in the year 2030 (midlife of operation). An estimated $1.1 \times 10^{-5}$ fatal cancers could result from 40 years of operation.

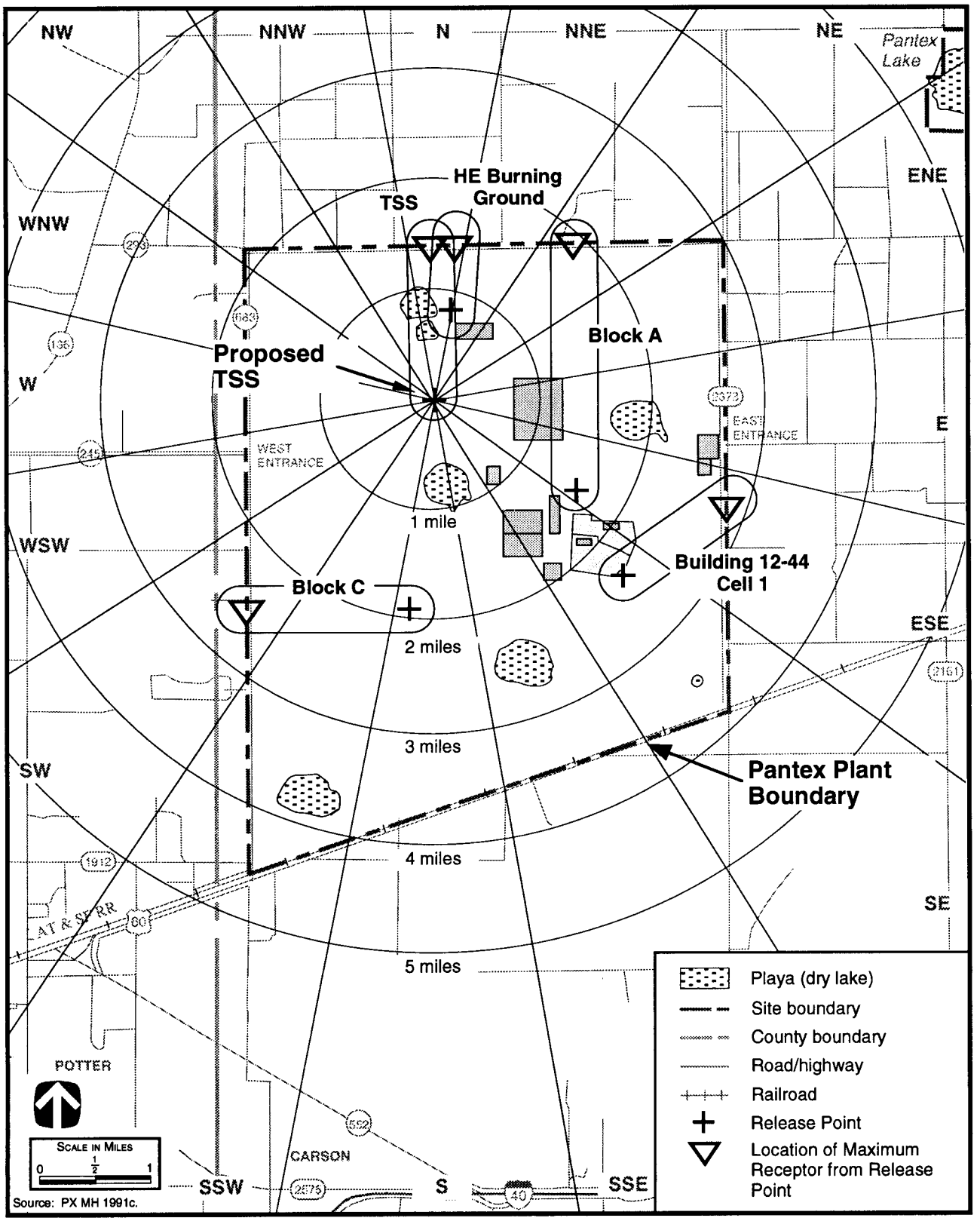
**Worker Doses.** Based on measured values during the time period of 1989 to 1992 (*Twenty-Second Annual Report Radiation Exposure for DOE and DOE Contractor Employees – 1989* DOE/EH-0286P)) and subsequent yearly dose reports), the annual average dose to a badged worker at Pantex was calculated to be 15 mrem. It is projected that in the year 2010 and beyond, there would be 2,465 badged workers involved in No Action activities at Pantex (PX 1993a:2). The annual average dose to these workers was assumed to remain at 15 mrem;

the annual total dose among all these workers would then equal 37 person-rem. From 40 years of operation, an estimated fatal cancer risk of 2.4x10-4 would result to the average worker and 0.59 fatal cancers could result among all workers.

### E.2.7.2 *Tritium Supply Technologies and Recycling*

Total site radiological impacts resulting from tritium supply and recycling can be found by adding the impacts resulting from No Action facilities to those resulting from tritium supply technologies and recycling facilities. For example, to determine the radiological impact for the addition of an HWR at Pantex, the No Action facilities impacts have to be summed with the HWR doses (which includes tritium target extrication) and the tritium recycling doses. Estimated annual atmospheric radioactive releases for the tritium supply technologies and recycling facilities are given in section E.2.3. Tables E.2.7.1–2 and E.2.7.1–3 present the radiological impacts by tritium supply technology and recycling facility. There are no radioactive liquid releases to the offsite environment associated with any tritium supply and recycling alternative.

The annual doses from total site operations associated with the different tritium supplies range from 1.4 to 4.9 mrem to the maximally exposed individual and from 9.2 to 37 person-rem to the 50-mile population in the year 2030. The health effects from 40 years of operation are included in both tables.




Source: PX MH 1991c.

5121-PAN/REC App

**FIGURE E.2.7–1.—*Location of Maximum Receptors at Pantex Plant.***

**TABLE E.2.7–1.—*Release Point Characteristics, Direction, Distance and Chi/Q at Pantex Plant Boundary***

| Release Point | Tritium Supply Site | | | | Burning Ground | | Building 12-44, Cell 1 | |
|---|---|---|---|---|---|---|---|---|
| Latitude | 35°19' 54.60" | | | | 35°20'40.78" | | 35°18' 24.09" | |
| Longitude | -101°35'15.15" | | | | -101°35'4.25" | | -101°33'25.59" | |
| Release Height: | Ground Level | | | | Ground Level | | Ground Level | |
| | | | Accidents | | | | | |
| Direction | Distance (m) | Chi/Q (sec/m$^3$) | 50 Percentile Chi/Q (sec/m$^3$) | 95 Percentile Chi/Q (sec/m$^3$) | Distance (m) | Chi/Q (sec/m$^3$) | Distance (m) | Chi/Q (sec/m$^3$) |
| N | 2,352 | $5.7\times10^{-7}$ | $8.0\times10^{-7}$ | $1.0\times10^{-4}$ | 932 | $2.7\times10^{-6}$ | 5,176 | $1.7\times10^{-7}$ |
| NNE | 2,397 | $3.4\times10^{-7}$ | $9.3\times10^{-7}$ | $1.0\times10^{-4}$ | 958 | $1.6\times10^{-6}$ | 2,910 | $2.5\times10^{-7}$ |
| NE | 2,822 | $2.2\times10^{-7}$ | $4.8\times10^{-7}$ | $7.6\times10^{-5}$ | 1,119 | $9.9\times10^{-7}$ | 2,258 | $3.1\times10^{-7}$ |
| ENE | 4,177 | $7.2\times10^{-8}$ | $2.3\times10^{-7}$ | $4.8\times10^{-5}$ | 1,654 | $3.1\times10^{-7}$ | 2,012 | $2.2\times10^{-7}$ |
| E | 4,245 | $8.0\times10^{-8}$ | $2.9\times10^{-7}$ | $5.3\times10^{-5}$ | 3,983 | $8.8\times10^{-8}$ | 1,872 | $2.8\times10^{-7}$ |
| ESE | 4,317 | $5.3\times10^{-8}$ | $5.2\times10^{-7}$ | $5.7\times10^{-5}$ | 4,062 | $5.8\times10^{-8}$ | 1,844 | $2.0\times10^{-7}$ |
| SE | 5,047 | $5.5\times10^{-8}$ | $3.9\times10^{-7}$ | $4.8\times10^{-5}$ | 5,036 | $5.5\times10^{-8}$ | 1,904 | $2.4\times10^{-7}$ |
| SSE | 6,165 | $3.1\times10^{-8}$ | $2.4\times10^{-7}$ | $3.6\times10^{-5}$ | 6,934 | $2.6\times10^{-8}$ | 2,578 | $1.1\times10^{-7}$ |
| S | 6,227 | $5.7\times10^{-8}$ | $1.0\times10^{-7}$ | $2.6\times10^{-5}$ | 7,472 | $4.4\times10^{-8}$ | 2,607 | $2.1\times10^{-7}$ |
| SSW | 5,121 | $4.6\times10^{-8}$ | $1.7\times10^{-7}$ | $3.9\times10^{-5}$ | 5,630 | $4.0\times10^{-8}$ | 2,998 | $1.0\times10^{-7}$ |
| SW | 3,348 | $7.7\times10^{-8}$ | $4.0\times10^{-7}$ | $7.2\times10^{-5}$ | 3,676 | $6.7\times10^{-8}$ | 4,285 | $5.3\times10^{-8}$ |
| WSW | 2,801 | $1.5\times10^{-7}$ | $1.8\times10^{-6}$ | $1.1\times10^{-4}$ | 3,087 | $1.3\times10^{-7}$ | 5,636 | $5.3\times10^{-8}$ |
| W | 2,724 | $1.5\times10^{-7}$ | $1.2\times10^{-6}$ | $1.1\times10^{-4}$ | 2,999 | $1.3\times10^{-7}$ | 5,495 | $5.4\times10^{-8}$ |
| WNW | 2,769 | $1.1\times10^{-7}$ | $6.1\times10^{-7}$ | $1.0\times10^{-4}$ | 1,742 | $2.4\times10^{-7}$ | 5,575 | $4.1\times10^{-8}$ |
| NW | 2,860 | $1.7\times10^{-7}$ | $5.6\times10^{-7}$ | $9.0\times10^{-5}$ | 1,151 | $7.6\times10^{-7}$ | 6,284 | $5.5\times10^{-8}$ |
| NNW | 2,411 | $2.3\times10^{-7}$ | $7.2\times10^{-7}$ | $9.8\times10^{-5}$ | 959 | $1.1\times10^{-6}$ | 5,297 | $7.1\times10^{-8}$ |

Source: HNUS 1995a.

**TABLE E.2.7–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at the Pantex Site Boundary***

| | Direction (m) | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| **Release Point: Tritium Supply Site** | | | | |
| | N. | 2372 | HE Burning Ground | $5.6 \times 10^{-7}$ |
| | ESE. | 4585 | Bldg. 12-44 Cell 1 | $4.9 \times 10^{-8}$ |
| | N. | 2351 | Tritium Supply Site | $5.7 \times 10^{-7}$ |
| | NE. | 3158 | Block A | $4.9 \times 10^{-8}$ |
| | SW. | 4272 | Block C | $5.6 \times 10^{-7}$ |
| **Release Point: Bldg. 12-44 Cell 1** | | | | |
| | NNW. | 5713 | HE Burning Ground | $6.4 \times 10^{-8}$ |
| | NE. | 1834 | Bldg. 12-44 Cell 1 | $4.3 \times 10^{-7}$ |
| | NNW. | 5845 | Tritium Supply Site | $6.2 \times 10^{-8}$ |
| | N. | 5213 | Block A | $4.3 \times 10^{-7}$ |
| | W. | 5518 | Block C | $6.4 \times 10^{-8}$ |
| **Release Point: HE Burning Ground** | | | | |
| | N. | 932 | HE Burning Ground | $2.7 \times 10^{-6}$ |
| | SE. | 5066 | Bldg. 12-44 Cell 1 | $5.5 \times 10^{-8}$ |
| | NNW. | 972 | Tritium Supply Site | $1.1 \times 10^{-6}$ |
| | ENE. | 2039 | Block A | $5.5 \times 10^{-8}$ |
| | SW. | 5588 | Block C | $2.7 \times 10^{-6}$ |
| **Release Point: Block A** | | | | |
| | NNW. | 3893 | HE Burning Ground | $1.1 \times 10^{-7}$ |
| | E. | 3893 | Bldg. 12-44 Cell 1 | $9.1 \times 10^{-8}$ |
| | NNW. | 4332 | Tritium Supply Site | $9.5 \times 10^{-8}$ |
| | N. | 3803 | Block A | $2.7 \times 10^{-7}$ |
| | WSW. | 5183 | Block C | $5.9 \times 10^{-8}$ |
| **Release Point: Block C** | | | | |
| | N. | 5664 | HE Burning Ground | $1.5 \times 10^{-7}$ |
| | ENE. | 4896 | Bldg. 12-44 Cell 1 | $5.7 \times 10^{-8}$ |
| | N. | 5633 | Tritium Supply Site | $1.5 \times 10^{-7}$ |
| | NNE. | 6162 | Block A | $8.3 \times 10^{-8}$ |
| | W. | 2339 | Block C | $1.9 \times 10^{-7}$ |

Source: HNUS 1995a

**TABLE E.2.7.1–2.—*Doses and Resulting Health Effect to the Maximally Exposed Individual at Pantex Resulting from Normal Operation***

| Alternative | Dose by Pathway (mrem per year) | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated 40-Year Fatal Cancer Risk |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | $1.3 \times 10^{-3}$ | $5.0 \times 10^{-6}$ | $1.2 \times 10^{-12}$ | $9.9 \times 10^{-8}$ | $1.3 \times 10^{-3}$ | $4.2 \times 10^{-4}$ | $2.6 \times 10^{-8}$ |
| No Action contribution to tritium supply site maximum receptor | $5.0 \times 10^{-4}$ | $2.9 \times 10^{-6}$ | $4.4 \times 10^{-13}$ | $3.8 \times 10^{-8}$ | $5.0 \times 10^{-4}$ | $1.5 \times 10^{-4}$ | $1.0 \times 10^{-8}$ |
| Heavy Water Reactor | 0.52 | 1.9 | $6.8 \times 10^{-3}$ | $2.4 \times 10^{-3}$ | 2.4 | 0.70 | $4.8 \times 10^{-5}$ |
| Modular High Temperature Gas-Cooled Reactor | 0.070 | 0.94 | $1.7 \times 10^{-3}$ | $7.9 \times 10^{-4}$ | 1.0 | 0.29 | $2.0 \times 10^{-5}$ |
| Advanced Boiling Water Reactor | 0.21 | 3.2 | 0.095 | $9.8 \times 10^{-3}$ | 3.5 | 1.0 | $7.0 \times 10^{-5}$ |
| CE System 80+ | 0.21 | 3.1 | $7.9 \times 10^{-3}$ | $4.2 \times 10^{-3}$ | 3.2 | 0.93 | $6.4 \times 10^{-5}$ |
| Simplified Boiling Water Reactor | 0.21 | 3.2 | 0.024 | 0.024 | 3.4 | 0.99 | $6.8 \times 10^{-5}$ |
| AP600 | 0.21 | 3.1 | 0.022 | $6.4 \times 10^{-3}$ | 3.3 | 0.96 | $6.6 \times 10^{-5}$ |
| Full Accelerator Production of Tritium with helium-3 | $2.4 \times 10^{-3}$ | 0.033 | $1.8 \times 10^{-4}$ | $3.7 \times 10^{-7}$ | 0.035 | 0.010 | $7.0 \times 10^{-7}$ |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | 0.049 | 0.66 | $1.8 \times 10^{-4}$ | $3.7 \times 10^{-7}$ | 0.71 | 0.21 | $1.4 \times 10^{-5}$ |
| Phased Accelerator Production of Tritium | $2.4 \times 10^{-3}$ | 0.033 | $8.9 \times 10^{-5}$ | $1.9 \times 10^{-7}$ | 0.035 | 0.010 | $7.0 \times 10^{-7}$ |
| Tritium Recycling | 0.099 | 1.3 | $9.4 \times 10^{-11}$ | 0.0 | 1.4 | 0.40 | $2.8 \times 10^{-5}$ |

[a] Individual annual background radiation dose is equal to 323 mrem.

Source: HNUS 1995a.

**TABLE E.2.7.1–3.—*Doses and Resulting Health Effect to the Population Within 50 Miles of Pantex Plant Resulting from Normal Operation***

| Alternative | Dose by Pathway (person-rem in 2030) | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | $4.5 \times 10^{-4}$ | $1.2 \times 10^{-4}$ | $5.4 \times 10^{-13}$ | $3.6 \times 10^{-8}$ | $5.7 \times 10^{-4}$ | $5.7 \times 10^{-4}$ | $1.1 \times 10^{-5}$ |
| Heavy Water Reactor | 0.92 | 17 | $8.5 \times 10^{-3}$ | $4.3 \times 10^{-3}$ | 19 | 0.019 | 0.37 |
| Modular High Temperature Gas-Cooled Reactor | 0.12 | 6.3 | $2.1 \times 10^{-3}$ | $1.1 \times 10^{-3}$ | 6.5 | $6.5 \times 10^{-3}$ | 0.13 |
| Advanced Boiling Water Reactor | 0.38 | 26 | 0.057 | 0.016 | 28 | 0.028 | 0.55 |
| CE System 80+ | 0.38 | 25 | 0.010 | $7.5 \times 10^{-3}$ | 26 | 0.026 | 0.51 |
| Simplified Boiling Water Reactor | 0.39 | 24 | 0.017 | 0.041 | 25 | 0.025 | 0.49 |
| AP600 | 0.38 | 25 | 0.033 | 0.012 | 26 | 0.026 | 0.51 |
| Full Accelerator Production of Tritium with helium-3 | $4.3 \times 10^{-3}$ | 0.22 | $2.5 \times 10^{-4}$ | $8.3 \times 10^{-9}$ | 0.23 | $2.3 \times 10^{-4}$ | $4.6 \times 10^{-3}$ |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | 0.087 | 4.4 | $2.5 \times 10^{-4}$ | $8.3 \times 10^{-9}$ | 4.5 | $4.5 \times 10^{-3}$ | 0.09 |
| Phased Accelerator Production of Tritium | $4.3 \times 10^{-3}$ | 0.22 | $1.3 \times 10^{-4}$ | $4.2 \times 10^{-9}$ | 0.23 | $2.3 \times 10^{-4}$ | $4.6 \times 10^{-3}$ |
| Tritium Recycling | 0.17 | 8.8 | $1.7 \times 10^{-10}$ | 0.0 | 9.0 | $9.0 \times 10^{-3}$ | 0.18 |

[a] Dose to the population within 50 miles from background radiation in 2030 is equal to 88,500 person-rem.
Source: HNUS 1995a.

## E.2.8 Radiological Impacts at Savannah River Site

This section presents the radiological impacts of the tritium supply technologies and recycling facilities at SRS. Section E.2.8.1 presents the radiological releases and resulting impacts from facilities associated with No Action. Section E.2.8.2 presents the radiological releases and resulting impacts from the facilities associated with the tritium supply technologies and recycling facilities.

For purposes of radiological impact modelling, SRS was divided into seven separate areas. All potential release points in each area were aggregated into a single release point. Table E.2.8–1 presents the characteristics of each of the release points including location, release height, and minimum distance and annual average dispersion to the site boundary in each of 16 directions. In order to calculate the maximum site boundary dose, the dose from each release point to the maximum receptor associated with each of the other release points has been calculated. For example, the dose resulting from releases from F-, H-, S-Areas, the K- and L-Reactors, and the proposed TSS is determined for the maximum receptor from the Savannah River Tech Center Laboratory in A-Area. Figure E.2.8–1 illustrates the location of each maximum receptor in relation to each release point. The maximum site boundary dose is then determined by the maximum dose of each of the maximum receptors. Table E.2.8–2 presents the direction, distance, and atmospheric dispersion from each release point to each of the maximum receptors. Annual radiological releases were assumed to remain constant during the 40-year operational period.

Descriptions of population and food stuffs distributions centered on each release area are provided in a technical report *Health Risk Data*. The joint frequency distribution used for the dose assessment was based on the meteorological measurements for the year 1985 from the meteorological tower at SRS at the 61 meter height and is contained in a technical report *Health Risk Data*.

Doses given in this section are associated with one year of operation because regulatory standards are given as annual limits. The health effects presented are for the 40-year operational period.

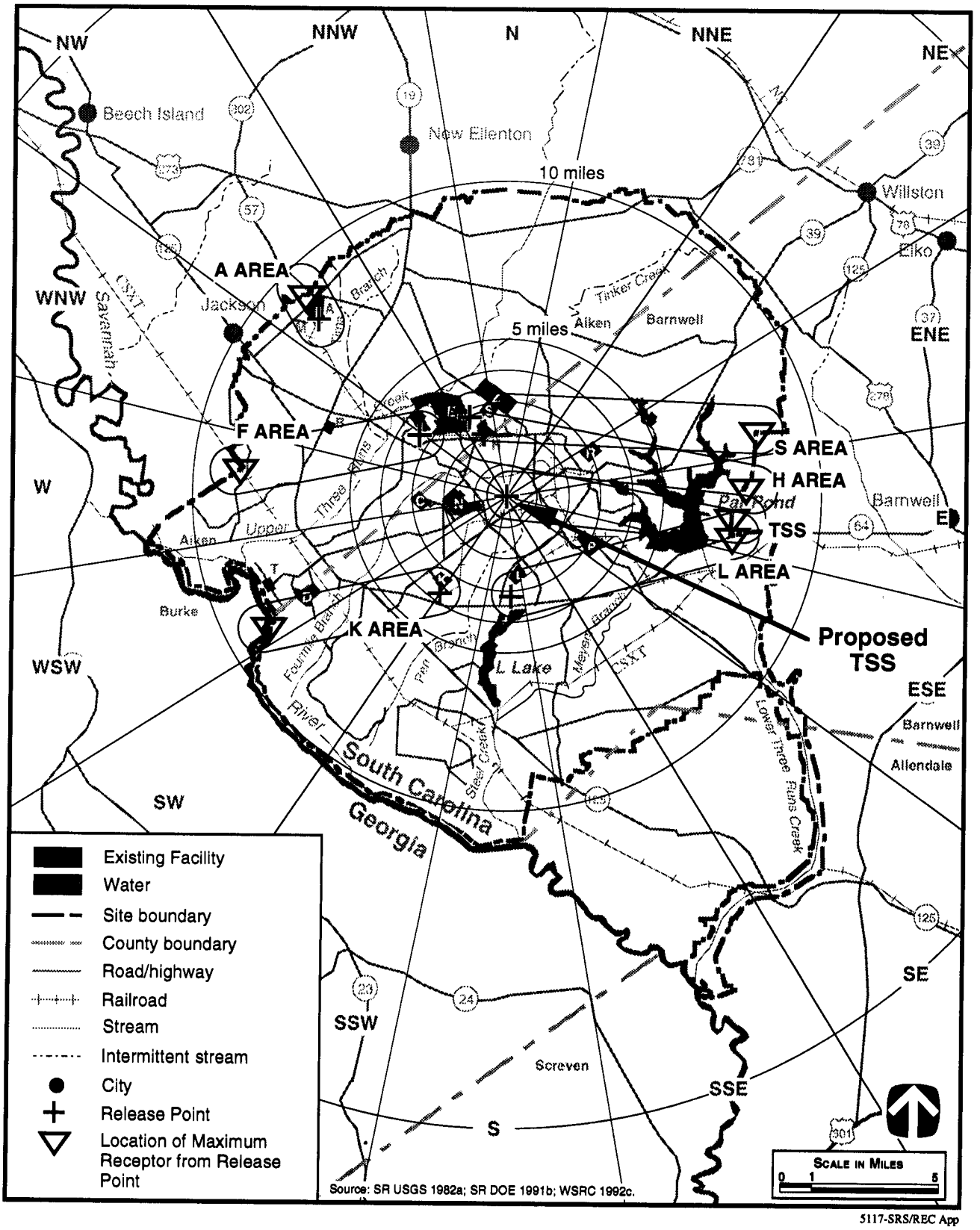



**FIGURE E.2.8–1.**—*Location of Maximum Receptors at Savannah River Site.*

**TABLE E.2.8–1.—*Release Point Characteristics, Direction, Distance, and Atmospheric Dispersion at Savannah River Site Boundary* [Page 1 of 2]**

| | A-Area | | F-Area | | H-Area | | | | K-Area | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Latitude** | 33°20'24 36" | | 33°17'11.40" | | 33°17'11.04" | | | | 33°12'42.12" | |
| **Longitude** | -81°44'6.72" | | -81°40'34.68" | | -81°38'25.07" | | | | -81°39'49.31" | |
| **Release Height:** | 10.0 meters | | 10.0 meters | | 10.0 meters | | | | 10.0 meters | |
| | | | | | | | **Accident** | | | |
| | | | | | | | **50 Percentile** | **95 Percentile** | | |
| **Direction** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Chi/Q (sec/m$^3$)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** |
| N. | 1,920 | $2.6\times10^{-6}$ | 10,895 | $2.3\times10^{-7}$ | 12,280 | $1.9\times10^{-7}$ | $5.6\times10^{-6}$ | $6.3\times10^{-5}$ | 19,112 | $1.1\times10^{-7}$ |
| NNE. | 3,260 | $1.5\times10^{-6}$ | 12,646 | $2.2\times10^{-7}$ | 12,860 | $2.2\times10^{-7}$ | $4.9\times10^{-6}$ | $9.0\times10^{-5}$ | 21,418 | $1.1\times10^{-7}$ |
| NE. | 5,447 | $8.2\times10^{-7}$ | 14,762 | $2.1\times10^{-7}$ | 14,889 | $2.1\times10^{-7}$ | $3.9\times10^{-6}$ | $5.8\times10^{-5}$ | 21,727 | $1.2\times10^{-7}$ |
| ENE. | 12,422 | $3.0\times10^{-7}$ | 18,536 | $1.7\times10^{-7}$ | 15,959 | $2.1\times10^{-7}$ | $3.4\times10^{-6}$ | $6.5\times10^{-5}$ | 15,630 | $2.2\times10^{-7}$ |
| E. | 21,490 | $1.6\times10^{-7}$ | 17,109 | $2.2\times10^{-7}$ | 14,055 | $2.8\times10^{-7}$ | $5.2\times10^{-6}$ | $8.0\times10^{-5}$ | 15,628 | $2.5\times10^{-7}$ |
| ESE. | 23,855 | $9.9\times10^{-8}$ | 16,944 | $1.6\times10^{-7}$ | 13,690 | $2.1\times10^{-7}$ | $5.0\times10^{-6}$ | $8.8\times10^{-5}$ | 13,427 | $2.1\times10^{-7}$ |
| SE. | 27,208 | $4.8\times10^{-8}$ | 19,773 | $7.3\times10^{-8}$ | 17,634 | $8.6\times10^{-8}$ | $3.9\times10^{-6}$ | $8.1\times10^{-5}$ | 11,434 | $1.5\times10^{-7}$ |
| SSE. | 25,922 | $3.3\times10^{-8}$ | 18,932 | $5.0\times10^{-8}$ | 17,662 | $5.5\times10^{-8}$ | $2.1\times10^{-6}$ | $5.0\times10^{-5}$ | 10,834 | $1.1\times10^{-7}$ |
| S. | 14,864 | $7.1\times10^{-8}$ | 18,520 | $5.3\times10^{-8}$ | 18,108 | $5.5\times10^{-8}$ | $8.9\times10^{-7}$ | $6.9\times10^{-5}$ | 11,121 | $1.1\times10^{-7}$ |
| SSW. | 7,327 | $2.7\times10^{-7}$ | 15,478 | $9.6\times10^{-8}$ | 18,479 | $7.6\times10^{-8}$ | $2.3\times10^{-6}$ | $5.7\times10^{-5}$ | 10,683 | $1.6\times10^{-7}$ |
| SW. | 5,280 | $6.9\times10^{-7}$ | 11,521 | $2.3\times10^{-7}$ | 14,338 | $1.7\times10^{-7}$ | $3.5\times10^{-6}$ | $5.4\times10^{-5}$ | 10,613 | $2.6\times10^{-7}$ |
| WSW. | 3,434 | $1.5\times10^{-6}$ | 9,639 | $3.5\times10^{-7}$ | 14,207 | $2.1\times10^{-7}$ | $3.6\times10^{-6}$ | $6.0\times10^{-5}$ | 9,147 | $3.8\times10^{-7}$ |
| W. | 2,588 | $1.8\times10^{-6}$ | 9,421 | $3.0\times10^{-7}$ | 12,768 | $2.0\times10^{-7}$ | $5.5\times10^{-6}$ | $6.8\times10^{-5}$ | 8,856 | $3.3\times10^{-7}$ |
| WNW. | 1,751 | $2.5\times10^{-6}$ | 9,838 | $2.2\times10^{-7}$ | 12,662 | $1.5\times10^{-7}$ | $4.8\times10^{-6}$ | $9.4\times10^{-5}$ | 12,320 | $1.6\times10^{-7}$ |
| NW. | 1,575 | $2.3\times10^{-6}$ | 9,459 | $1.8\times10^{-7}$ | 11,893 | $1.3\times10^{-7}$ | $4.9\times10^{-6}$ | $1.0\times10^{-4}$ | 13,277 | $1.1\times10^{-7}$ |
| NNW. | 1,395 | $2.7\times10^{-6}$ | 9,963 | $1.7\times10^{-7}$ | 11,750 | $1.4\times10^{-7}$ | $5.3\times10^{-6}$ | $5.8\times10^{-5}$ | 17,101 | $8.3\times10^{-8}$ |

**TABLE E.2.8–1.—*Release Point Characteristics, Direction, Distance, and Atmospheric Dispersion at Savannah River Site Boundary* [Page 2 of 2]**

| | L-Area | | S-Area | | Tritium Supply Site | | | |
|---|---|---|---|---|---|---|---|---|
| **Latitude** | 33°12'38.52" | | 33°17'42.72" | | 33°15'28.80" | | | |
| **Longitude** | -81°37'26.40" | | -81°38'35.15" | | -81°37'33.96" | | | |
| **Release Height:** | 10.0 meters | | 10.0 meters | | 10.0 meters | | | |
| | | | | | | | **Accident** | |
| **Direction** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **Distance (m)** | **Chi/Q (sec/m$^3$)** | **50 Percentile Chi/Q (sec/m$^3$)** | **95 Percentile Chi/Q (sec/m$^3$)** |
| N. | 20,731 | $9.6\times10^{-8}$ | 11,286 | $2.2\times10^{-7}$ | 15,564 | $1.4\times10^{-7}$ | $4.0\times10^{-6}$ | $4.7\times10^{-5}$ |
| NNE. | 21,141 | $1.1\times10^{-7}$ | 11,984 | $2.4\times10^{-7}$ | 15,856 | $1.6\times10^{-7}$ | $3.7\times10^{-6}$ | $6.9\times10^{-5}$ |
| NE. | 15,520 | $1.9\times10^{-7}$ | 14,240 | $2.2\times10^{-7}$ | 16,560 | $1.8\times10^{-7}$ | $3.4\times10^{-6}$ | $5.0\times10^{-5}$ |
| ENE. | 12,052 | $3.1\times10^{-7}$ | 15,663 | $2.2\times10^{-7}$ | 13,279 | $2.7\times10^{-7}$ | $4.4\times10^{-6}$ | $8.1\times10^{-5}$ |
| E. | 13,327 | $3.1\times10^{-7}$ | 14,623 | $2.7\times10^{-7}$ | 11,822 | $3.6\times10^{-7}$ | $6.7\times10^{-6}$ | $9.9\times10^{-5}$ |
| ESE. | 11,184 | $2.7\times10^{-7}$ | 14,223 | $2.0\times10^{-7}$ | 11,822 | $3.6\times10^{-7}$ | $4.7\times10^{-6}$ | $8.3\times10^{-5}$ |
| SE. | 9,886 | $1.9\times10^{-7}$ | 18,443 | $8.1\times10^{-8}$ | 14,551 | $1.1\times10^{-7}$ | $5.1\times10^{-6}$ | $1.0\times10^{-4}$ |
| SSE. | 9,298 | $1.3\times10^{-7}$ | 18,667 | $8.1\times10^{-8}$ | 14,255 | $7.4\times10^{-8}$ | $2.8\times10^{-6}$ | $6.5\times10^{-5}$ |
| S. | 9,587 | $1.3\times10^{-7}$ | 19,113 | $5.1\times10^{-8}$ | 14,819 | $7.2\times10^{-8}$ | $1.2\times10^{-6}$ | $8.9\times10^{-5}$ |
| SSW. | 12,157 | $1.3\times10^{-7}$ | 19,048 | $7.3\times10^{-8}$ | 16,910 | $8.5\times10^{-8}$ | $2.6\times10^{-6}$ | $6.3\times10^{-5}$ |
| SW. | 12,497 | $2.1\times10^{-7}$ | 14,544 | $1.7\times10^{-7}$ | 15,675 | $1.5\times10^{-7}$ | $3.1\times10^{-6}$ | $4.8\times10^{-5}$ |
| WSW. | 13,516 | $2.2\times10^{-7}$ | 12,868 | $2.4\times10^{-7}$ | 13,864 | $2.1\times10^{-7}$ | $3.7\times10^{-6}$ | $6.2\times10^{-5}$ |
| W. | 12,508 | $2.0\times10^{-7}$ | 12,473 | $2.0\times10^{-7}$ | 14,146 | $1.7\times10^{-7}$ | $4.8\times10^{-6}$ | $6.0\times10^{-5}$ |
| WNW. | 15,662 | $1.1\times10^{-7}$ | 11,487 | $1.7\times10^{-7}$ | 14,384 | $1.3\times10^{-7}$ | $4.1\times10^{-6}$ | $8.0\times10^{-5}$ |
| NW. | 17,091 | $8.2\times10^{-8}$ | 10.982 | $1.5\times10^{-7}$ | 14,974 | $9.8\times10^{-8}$ | $3.6\times10^{-6}$ | $7.9\times10^{-5}$ |
| NNW. | 19,321 | $7.0\times10^{-8}$ | 10,741 | $1.5\times10^{-7}$ | 15,132 | $9.7\times10^{-8}$ | $3.8\times10^{-6}$ | $4.3\times10^{-5}$ |

Source: HNUS 1995a.

**TABLE E.2.8–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at Savannah River Site Boundary* [Page 1 of 2]**

| | Direction | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| **Release Point: A- Area** | | | | |
| | NNW. | 1,396 | A-Area | $2.7 \times 10^{-6}$ |
| | SSW. | 9,638 | F-Area | $2.1 \times 10^{-7}$ |
| | ESE | 24,209 | H-Area | $9.7 \times 10^{-8}$ |
| | S. | 16,255 | K-Area | $6.3 \times 10^{-8}$ |
| | ESE. | 24,650 | L-Area | $9.5 \times 10^{-8}$ |
| | E. | 23,833 | S-Area | $1.4 \times 10^{-7}$ |
| | ESE. | 24,175 | Tritium Supply Site | $9.7 \times 10^{-8}$ |
| **Release Point: F-Area** | | | | |
| | NW. | 9,460 | A-Area | $1.8 \times 10^{-7}$ |
| | WSW. | 9,638 | F-Area | $3.5 \times 10^{-7}$ |
| | E. | 17,358 | H-Area | $2.1 \times 10^{-7}$ |
| | SW. | 12,787 | K-Area | $2.0 \times 10^{-7}$ |
| | ESE. | 17,299 | L-Area | $1.5 \times 10^{-7}$ |
| | E. | 17,704 | S-Area | $2.1 \times 10^{-7}$ |
| | ESE. | 16,980 | Tritium Supply Site | $1.5 \times 10^{-7}$ |
| **Release Point: H-Area** | | | | |
| | NW. | 11,932 | A-Area | $1.3 \times 10^{-7}$ |
| | W. | 12,930 | F-Area | $1.9 \times 10^{-7}$ |
| | E. | 14,055 | H-Area | $2.8 \times 10^{-7}$ |
| | SW. | 15,055 | K-Area | $1.6 \times 10^{-7}$ |
| | ESE. | 14,139 | L-Area | $2.0 \times 10^{-7}$ |
| | E. | 14,357 | S-Area | $2.8 \times 10^{-7}$ |
| | ESE. | 13,760 | Tritium Supply Site | $2.1 \times 10^{-7}$ |
| **Release Point: K Reactor** | | | | |
| | NNW. | 17,101 | A-Area | $8.3 \times 10^{-8}$ |
| | WNW. | 12,320 | F-Area | $1.6 \times 10^{-7}$ |
| | ENE. | 16,962 | H-Area | $1.9 \times 10^{-7}$ |
| | WSW. | 9,146 | K-Area | $3.8 \times 10^{-7}$ |
| | E. | 15,627 | L-Area | $2.5 \times 10^{-7}$ |
| | ENE. | 18,642 | S-Area | $1.7 \times 10^{-7}$ |

**TABLE E.2.8–2.—*Direction, Distance, and Meteorological Dispersion to Various Maximum Individual Receptors at Savannah River Site Boundary* [Page 2 of 2]**

| | Direction | Distance (m) | Maximum Receptor | Atmospheric Dispersion Chi/Q (sec/m$^3$) |
|---|---|---|---|---|
| | ENE. | 15,803 | Tritium Supply Site | $2.1 \times 10^{-7}$ |
| **Release Point: L Reactor** | | | | |
| | NW. | 19,081 | A-Area | $7.1 \times 10^{-8}$ |
| | WNW. | 15,661 | F-Area | $1.1 \times 10^{-7}$ |
| | ENE. | 13,579 | H-Area | $2.6 \times 10^{-7}$ |
| | W. | 12,775 | K-Area | $2.0 \times 10^{-7}$ |
| | ENE. | 12,051 | L-Area | $3.1 \times 10^{-7}$ |
| | NE. | 15,519 | S-Area | $1.9 \times 10^{-7}$ |
| | ENE. | 12,302 | Tritium Supply Site | $3.0 \times 10^{-7}$ |
| **Release Point: S-Area** | | | | |
| | NW. | 11,159 | A-Area | $1.5 \times 10^{-7}$ |
| | WSW. | 12,867 | F-Area | $2.4 \times 10^{-7}$ |
| | ESE. | 14,517 | H-Area | $1.9 \times 10^{-7}$ |
| | SW. | 15,548 | K-Area | $1.5 \times 10^{-7}$ |
| | ESE. | 14,759 | L-Area | $1.9 \times 10^{-7}$ |
| | E. | 14,622 | S-Area | $2.7 \times 10^{-7}$ |
| | ESE. | 14,328 | Tritium Supply Site | $1.9 \times 10^{-7}$ |
| **Release Point: Tritium Supply Site** | | | | |
| | NW. | 14,974 | A-Area | $9.8 \times 10^{-8}$ |
| | W. | 14,146 | F-Area | $1.7 \times 10^{-7}$ |
| | E. | 12,498 | H-Area | $2.1 \times 10^{-7}$ |
| | WSW. | 14,285 | K-Area | $2.1 \times 10^{-7}$ |
| | E. | 12,001 | L-Area | $3.5 \times 10^{-7}$ |
| | ENE. | 13,487 | S-Area | $2.6 \times 10^{-7}$ |
| | E. | 11,822 | Tritium Supply Site | $3.6 \times 10^{-7}$ |

Source: HNUS 1995a.

### E.2.8.1 *No Action*

**Atmospheric Releases.** For No Action, all of the areas have radioactive releases to the atmosphere from normal operation. Table E.2.8.1–1 and E.2.8.1–2 presents the estimated annual atmospheric radioactive releases. Tables E.2.8.1–3 and E.2.8.1–4 present the radiological impacts to the maximally exposed individual and the offsite population within 50 miles, respectively. The maximally exposed individual would receive an annual dose of 2.8 mrem. An estimated fatal cancer risk of $5.6 \times 10^{-5}$ would result from 40 years of operation. The population within 50 miles would receive a dose of 250 person-rem in the year 2030 (midlife of operation). An estimated 4.9 fatal cancers could result from 40 years of operation.

**Liquid Releases.** For No Action, some areas may have radioactive releases to the offsite surface water from normal operation. Table E.2.8.1–5 presents the estimated annual liquid radioactive releases.

Tables E.2.8.1–6 and E.2.8.1–7 present the radiological impacts to the maximally exposed member of the public and the offsite populations using water from the Savannah River downstream of SRS to the Atlantic Ocean. The maximally exposed member of the public would receive an annual dose of 0.077 mrem. An estimated fatal cancer risk of $1.5 \times 10^{-6}$ would result from 40 years of operation. The population would receive a dose of 0.45 person-rem in the year 2030. An estimated $9.0 \times 10^{-3}$ fatal cancers could result from 40 years of operation.

**Worker Doses.** It is projected that the annual average dose among the 14,864 badged workers involved in No Action activities at SRS in the year 2010 and beyond would be 32 mrem and the annual total dose among all these workers would equal 480 person-rem (SRS 1993a:3). From 40 years of operation, an estimated fatal cancer risk of $5.2 \times 10^{-4}$ would result to the average worker and 7.7 fatal cancers could result from all workers.

### E.2.8.2 *Tritium Supply Technologies and Recycling*

**Atmospheric Releases.** For the tritium supply technologies and recycling facilities, total site radiological impacts resulting from tritium supply technologies and recycling facilities can be found by adding the impacts resulting from No Action facilities to those resulting from tritium supply technologies and recycling facilities. For example, to determine the radiological impact for the addition of an HWR at SRS, the No Action facilities doses have to be summed with the HWR doses (which includes tritium target extraction) and the tritium recycling doses. Estimated annual atmospheric radioactive releases for the tritium supply and recycling facilities are given in section E.2.3. Tables E.2.8.1–3 and E.2.8.1–4 present the radiological impacts by tritium supply technology and recycling facility.

The annual doses from total site operations associated with the different tritium supplies range from 2.5 to 3.9 mrem to the maximally exposed individual and from 220 to 340 person-rem to the 50-mile population in the year 2030. The health effects from 40 years of operation are included in both tables.

**Liquid Releases.** There are three technologies that would release liquid discharges to the surface water surrounding SRS. These are the HWR and the Large and Small ALWRs. The liquid releases for these two technologies are given in section E.2.3. For example, to determine the liquid radiological impact for the addition of a HWR at SRS, the No Action liquid radiological impacts must be summed with the HWR liquid doses. Tables E.2.8.1–5 and E.2.8.1–6 present the liquid radiological impacts for the applicable alternatives.

The annual incremental doses from total site operation associated with the different tritium supplies that would release liquids range from 0.086 to 0.19 mrem to the maximally exposed member of the public and from 0.50 to 3.3 person-rem to the downstream population in the year 2030. The health effects from 40 years of operation are included in both tables.

**TABLE E.2.8.1–1.—*Annual Atmospheric Radioactive Releases from Normal Operation of No Action at Savannah River Site (curies)***

| Isotope | SRTC | K-Reactor | L-Reactor | F-Canyon | H-Canyon | RBOF |
|---|---|---|---|---|---|---|
| H-3 | 0.0 | $3.9x10^{3}$ | 670 | 0.0 | 0.0 | 0.0 |
| C-14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ar-41 | 0.0 | 25 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cr-51 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Co-60 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | $3.6x10^{-7}$ |
| Se-79 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sr-89 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sr-90 | 0.0 | 0.0 | 0.0 | $2.6x10^{-5}$ | $1.1x10^{-4}$ | 0.0 |
| Y-90 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Y-91 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Zr-95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Nb-95 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Tc-99 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ru-106 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Rh-106 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sn-126 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sb-125 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Te-125m | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Te-127m | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Te-127 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| I-129 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| I-131 | $5.7x10^{-5}$ | $1.4x10^{-7}$ | 0.0 | 0.0 | $2.1x10^{-5}$ | 0.0 |
| I-133 | $1.2x10^{-3}$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| I-135 | 0.13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Xe-135 | $2.4x10^{-3}$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cs-134 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cs-135 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cs-137 | $3.9x10^{-6}$ | $4.1x10^{-7}$ | $2.6x10^{-6}$ | $8.5x10^{-6}$ | $8.7x10^{-5}$ | $1.7x10^{-6}$ |
| Ce-144 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pr-144 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pm-147 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Sm-151 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Eu-152 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Eu-154 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Eu-155 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| U-235 | 0.0 | 0.0 | 0.0 | $7.3x10^{-4}$ | $3.7x10^{-5}$ | 0.0 |
| Pu-238 | 0.0 | 0.0 | 0.0 | $4.1x10^{-5}$ | $1.8x10^{-4}$ | 0.0 |
| Pu-239 | 0.0 | 0.0 | 0.0 | $1.6x10^{-4}$ | $5.6x10^{-5}$ | 0.0 |
| Pu-240 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pu-241 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Am-241 | $2.3x10^{-8}$ | 0.0 | 0.0 | $2.4x10^{-4}$ | $2.4x10^{-5}$ | 0.0 |
| Cm-244 | $7.9x10^{-8}$ | 0.0 | 0.0 | $3.6x10^{-6}$ | $7.5x10^{-6}$ | 0.0 |

Note: SRTC - Savannah River Technology Center; RBOF - Receiving Basin for Offsite Fuels.
Source: SRS 1993a:3.

**TABLE E.2.8.1–2.—*Annual Atmospheric Radioactive Releases from Waste Management Facilities During Normal Operation of No Action at Savannah River Site (curies)***

| Isotope | Waste Management F-Area | Waste Management H-Area | Tritium Facilities | DWPF | Consolidated Incineration Facility |
|---|---|---|---|---|---|
| H-3 | 0.0 | $2.1x10^{-5}$ | $3.5x10^{4}$ | 20 | $1.2x10^{3}$ |
| C-14 | 0.0 | 0.0 | 0.0 | 0.021 | 0.0 |
| Ar-41 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cr-51 | 0.0 | 0.0 | 0.0 | 0.0 | 0.015 |
| Co-60 | 0.0 | 0.0 | 0.0 | $6.1x10^{-8}$ | $1.4x10^{-4}$ |
| Se-79 | 0.0 | 0.0 | 0.0 | $8.8x10^{-9}$ | 0.0 |
| Sr-89 | 0.0 | 0.0 | 0.0 | 0.0 | $6.0x10^{-4}$ |
| Sr-90 | 0.0 | 0.0 | 0.0 | $2.3x10^{-5}$ | 0.022 |
| Y-90 | 0.0 | 0.0 | 0.0 | $2.4x10^{-5}$ | $7.6x10^{-5}$ |
| Y-91 | 0.0 | 0.0 | 0.0 | 0.0 | $4.5x10^{-4}$ |
| Zr-95 | 0.0 | 0.0 | 0.0 | 0.0 | $4.7x10^{-4}$ |
| Nb-95 | 0.0 | 0.0 | 0.0 | 0.0 | $1.5x10^{-3}$ |
| Tc-99 | 0.0 | 0.0 | 0.0 | $3.8x10^{-7}$ | 0.0 |
| Ru-106 | 0.0 | $1.8x10^{-6}$ | 0.0 | $3.2x10^{-5}$ | $1.8x10^{-4}$ |
| Rh-106 | 0.0 | 0.0 | 0.0 | 0.0 | $1.8x10^{-4}$ |
| Sn-126 | 0.0 | 0.0 | 0.0 | $6.9x10^{-8}$ | 0.0 |
| Sb-125 | 0.0 | 0.0 | 0.0 | $6.7x10^{-7}$ | 0.0 |
| Te-125m | 0.0 | 0.0 | 0.0 | $1.0x10^{-5}$ | 0.0 |
| Te-127m | 0.0 | 0.0 | 0.0 | $4.5x10^{-9}$ | 0.0 |
| Te-127 | 0.0 | 0.0 | 0.0 | $4.4x10^{-9}$ | 0.0 |
| I-129 | 0.0 | 0.0 | 0.0 | $8.2x10^{-5}$ | 0.0 |
| I-131 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| I-133 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| I-135 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Xe-135 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cs-134 | 0.0 | $3.7x10^{-8}$ | 0.0 | $2.9x10^{-5}$ | 0.0 |
| Cs-135 | 0.0 | 0.0 | 0.0 | $9.4x10^{-7}$ | 0.0 |
| Cs-137 | $5.0x10^{-6}$ | $2.0x10^{-5}$ | 0.0 | $4.1x10^{-3}$ | $2.4x10^{-4}$ |
| Ce-144 | 0.0 | $1.2x10^{-7}$ | 0.0 | $3.0x10^{-6}$ | $2.3x10^{-4}$ |
| Pr-144 | 0.0 | 0.0 | 0.0 | $3.1x10^{-6}$ | $2.3x10^{-4}$ |
| Pm-147 | 0.0 | 0.0 | 0.0 | $7.6x10^{-6}$ | $9.1x10^{-4}$ |
| Sm-151 | 0.0 | 0.0 | 0.0 | $1.6x10^{-7}$ | 0.0 |
| Eu-152 | 0.0 | 0.0 | 0.0 | $1.4x10^{-9}$ | 0.0 |
| Eu-154 | 0.0 | 0.0 | 0.0 | $2.3x10^{-7}$ | 0.0 |
| Eu-155 | 0.0 | 0.0 | 0.0 | $1.6x10^{-7}$ | 0.0 |
| U-235 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Pu-238 | 0.0 | 0.0 | 0.0 | $7.9x10^{-7}$ | $1.4x10^{-4}$ |
| Pu-239 | 0.0 | 0.0 | 0.0 | $7.1x10^{-9}$ | $5.2x10^{-7}$ |
| Pu-240 | 0.0 | 0.0 | 0.0 | $4.8x10^{-9}$ | 0.0 |
| Pu-241 | 0.0 | 0.0 | 0.0 | $7.7x10^{-7}$ | 0.0 |
| Am-241 | 0.0 | 0.0 | 0.0 | $8.6x10^{-9}$ | 0.0 |
| Cm-244 | 0.0 | 0.0 | 0.0 | $2.7x10^{-8}$ | 0.0 |

Note: DWPF - Defense Waste Processing Waste Facility.
Source: SRS 1993a:3.

**TABLE E.2.8.1–3.—*Doses and Resulting Health Effect to Maximally Exposed Individual from Atmospheric Releases Associated with Normal Operation at Savannah River Site***

| Alternative | Dose by Pathway (mrem per year) | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated 40-Year Fatal Cancer Risk |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | 0.2 | 2.6 | $2.8 \times 10^{-4}$ | $6.9 \times 10^{-5}$ | 2.8 | 0.89 | $5.6 \times 10^{-5}$ |
| No Action with Tritium Upgrade | 0.15 | 1.8 | $2.8 \times 10^{-4}$ | $6.9 \times 10^{-5}$ | 2.0 | 0.63 | $4.0 \times 10^{-5}$ |
| Heavy Water Reactor | 0.059 | 0.93 | $2.2 \times 10^{-3}$ | $1.0 \times 10^{-4}$ | 0.99 | 0.31 | $2.0 \times 10^{-5}$ |
| Modular High Temperature Gas-Cooled Reactor | 0.036 | 0.50 | $5.3 \times 10^{-4}$ | $3.3 \times 10^{-4}$ | 0.53 | 0.17 | $1.1 \times 10^{-5}$ |
| Advanced Boiling Water Reactor | 0.076 | 1.2 | 0.012 | $3.8 \times 10^{-3}$ | 1.3 | 0.42 | $2.6 \times 10^{-5}$ |
| CE System 80+ | 0.094 | 1.4 | $2.8 \times 10^{-3}$ | $1.0 \times 10^{-4}$ | 1.5 | 0.46 | $2.9 \times 10^{-5}$ |
| Simplified Boiling Water Reactor | 0.065 | 1.1 | $4.0 \times 10^{-3}$ | 0.012 | 1.1 | 0.36 | $2.2 \times 10^{-5}$ |
| AP600 | 0.034 | 0.6 | $9.4 \times 10^{-3}$ | $1.1 \times 10^{-3}$ | 0.64 | 0.20 | $1.3 \times 10^{-5}$ |
| Full Accelerator Production of Tritium with helium-3 | $1.2 \times 10^{-3}$ | 0.017 | $6.2 \times 10^{-5}$ | $6.7 \times 10^{-12}$ | 0.018 | $5.7 \times 10^{-3}$ | $3.6 \times 10^{-7}$ |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | 0.024 | 0.33 | $6.2 \times 10^{-5}$ | $6.7 \times 10^{-12}$ | 0.35 | 0.11 | $7.0 \times 10^{-6}$ |
| Phased Accelerator Production of Tritium | $1.2 \times 10^{-3}$ | 0.017 | $3.2 \times 10^{-5}$ | $3.4 \times 10^{-12}$ | 0.018 | $5.7 \times 10^{-3}$ | $3.6 \times 10^{-7}$ |
| Tritium Recycling | 0.14 | 2.0 | $1.4 \times 10^{-10}$ | 0.0 | 2.1 | 0.67 | $4.2 \times 10^{-5}$ |
| Tritium Recycling Upgrade | 0.088 | 1.2 | $7.9 \times 10^{-11}$ | 0.0 | 1.3 | 0.41 | $2.6 \times 10^{-5}$ |

[a] Individual annual background radiation dose is equal to 315 mrem.

Source: HNUS 1995a.

**TABLE E.2.8.1–4.—*Doses and Resulting Health Effect to the Population Within 50 Miles of Savannah River Site from Atmospheric Releases Associated with Normal Operation***

| Alternative | Dose by Pathway (person-rem in 2030) | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|
| | Inhalation | Ingestion | Plume Immersion | Ground Shine | | | |
| No Action | 13 | 230 | $6.8 \times 10^{-3}$ | $8.0 \times 10^{-3}$ | 250 | 0.11 | 4.9 |
| No Action with Recycle Upgrade | 10 | 160 | $6.8 \times 10^{-3}$ | $8.0 \times 10^{-3}$ | 180 | 0.075 | 3.5 |
| Heavy Water Reactor | 3.3 | 84 | 0.051 | $4.6 \times 10^{-3}$ | 87 | 0.037 | 1.7 |
| Modular High Temperature Gas-Cooled Reactor | 2.1 | 40 | 0.01 | 0.013 | 42 | 0.018 | 0.84 |
| Advanced Boiling Water Reactor | 4.2 | 110 | 0.36 | 0.16 | 110 | 0.048 | 2.2 |
| CE System 80+ | 5.0 | 120 | 0.089 | $4.8 \times 10^{-3}$ | 120 | 0.053 | 2.5 |
| Simplified Boiling Water Reactor | 3.5 | 85 | 0.13 | 0.58 | 89 | 0.038 | 1.8 |
| AP600 | 2.0 | 60 | 0.32 | 0.056 | 62 | 0.027 | 1.2 |
| Full Accelerator Production of Tritium with helium-3 | 0.079 | 1.4 | $8.9 \times 10^{-4}$ | $4.9 \times 10^{-11}$ | 1.5 | $6.4 \times 10^{-4}$ | 0.030 |
| Full Accelerator Production of Tritium with spallation-induced lithium conversion | 1.5 | 28 | $8.9 \times 10^{-4}$ | $4.9 \times 10^{-11}$ | 29 | 0.012 | 0.58 |
| Phased Accelerator Production of Tritium | 0.079 | 1.4 | $4.5 \times 10^{-4}$ | $2.5 \times 10^{-11}$ | 1.5 | $6.4 \times 10^{-4}$ | 0.030 |
| Tritium Recycling | 9.0 | 170 | $8.7 \times 10^{-9}$ | 0.0 | 180 | 0.077 | 3.6 |
| Tritium Recycling Upgrade | 5.6 | 100 | $5.3 \times 10^{-9}$ | 0.0 | 110 | 0.047 | 2.2 |

[a] Dose to the population within 50 miles from background radiation in year 2030 is equal to 240,000 person-rem.

Source: HNUS 1995a.

**TABLE E.2.8.1–5.—*Annual Liquid Radioactive Releases from Normal Operation of No Action at Savannah River Site (curies)***

| Isotope | Savannah River Site Release | Isotope | Savannah River Site Release |
|---|---|---|---|
| H-3 | $1.4 \times 10^{3}$ | Cs-137 | 0.079 |
| S-35 | $3.2 \times 10^{-5}$ | Pm-147 | $2.7 \times 10^{-4}$ |
| Co-60 | $4.8 \times 10^{-5}$ | U-235 | $1.4 \times 10^{-5}$ |
| Sr-90 | $9.0 \times 10^{-3}$ | Pu-238 | $1.3 \times 10^{-5}$ |
| Y-91 | $2.0 \times 10^{-5}$ | Pu-239 | $3.5 \times 10^{-4}$ |
| Sb-125 | $7.2 \times 10^{-5}$ | Am-241 | $6.9 \times 10^{-7}$ |
| Cs-134 | $2.2 \times 10^{-5}$ | Cm-244 | $2.0 \times 10^{-7}$ |

Source: SRS 1993a:3.

**TABLE E.2.8.1–6.—*Doses and Resulting Health Effect to the Maximally Exposed Member of the Public from Liquid Releases Associated with Normal Operation at Savannah River Site***

| Alternative | Dose by Pathway (mrem per year) | | | | | | Committed Effective Dose Equivalent (mrem per year) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|---|---|
| | Fish Ingestion | Other Food Ingestion | Drinking Water | Boating | Swimming | Shoreline | | | |
| No Action | 0.065 | $2.6 \times 10^{-3}$ | $8.4 \times 10^{-3}$ | $6.5 \times 10^{-7}$ | $1.3 \times 10^{-6}$ | $1.9 \times 10^{-4}$ | 0.077 | 0.024 | $1.5 \times 10^{-6}$ |
| Heavy Water Reactor | 0.076 | $1.9 \times 10^{-3}$ | $8.4 \times 10^{-3}$ | $2.3 \times 10^{-6}$ | $4.6 \times 10^{-6}$ | $2.0 \times 10^{-4}$ | 0.086 | 0.027 | $1.7 \times 10^{-6}$ |
| Advanced Boiling Water Reactor | 0.023 | 0.017 | 0.057 | $7.0 \times 10^{-7}$ | $1.4 \times 10^{-6}$ | $1.5 \times 10^{-4}$ | 0.097 | 0.031 | $1.9 \times 10^{-6}$ |
| CE System 80+ | 0.057 | $6.6 \times 10^{-3}$ | 0.023 | $2.1 \times 10^{-6}$ | $4.3 \times 10^{-6}$ | $3.7 \times 10^{-4}$ | 0.087 | 0.027 | $1.7 \times 10^{-6}$ |
| Simplified Boiling Water Reactor | 0.023 | 0.017 | 0.057 | $7.0 \times 10^{-7}$ | $1.4 \times 10^{-6}$ | $1.5 \times 10^{-4}$ | 0.097 | 0.031 | $1.9 \times 10^{-6}$ |
| AP600 | 0.075 | 0.026 | 0.086 | $2.1 \times 10^{-6}$ | $4.2 \times 10^{-6}$ | $4.1 \times 10^{-4}$ | 0.19 | 0.060 | $3.8 \times 10^{-6}$ |

[a] Individual annual background radiation dose is equal to 315 mrem.
Source: HNUS 1995a.

**TABLE E.2.8.1–7.—*Doses and Resulting Health Effect to the Population from Liquid Releases Associated with Normal Operation Downstream of Savannah River Site***

| Facility | Dose by Pathway (person-rem in 2030) | | | | | Committed Effective Dose Equivalent in 2030 (person-rem) | Percent of Background[a] | Estimated 40-Year Fatal Cancers |
|---|---|---|---|---|---|---|---|---|
| | Fish Ingestion | Drinking Water | Boating | Swimming | Shoreline | | | |
| No Action | 0.16 | 0.29 | $7.1 \times 10^{-6}$ | $2.1 \times 10^{-6}$ | $3.6 \times 10^{-4}$ | 0.45 | $2.0 \times 10^{-4}$ | $9.0 \times 10^{-3}$ |
| Heavy Water Reactor | 0.28 | 0.22 | $2.6 \times 10^{-5}$ | $7.4 \times 10^{-6}$ | $3.9 \times 10^{-4}$ | 0.5 | $2.2 \times 10^{-4}$ | 0.01 |
| Advanced Boiling Water Reactor | 0.12 | 2.0 | $7.6 \times 10^{-6}$ | $2.2 \times 10^{-6}$ | $2.8 \times 10^{-4}$ | 2.1 | $9.5 \times 10^{-4}$ | 0.042 |
| CE System 80+ | 0.25 | 0.75 | $2.4 \times 10^{-5}$ | $6.8 \times 10^{-6}$ | $7.1 \times 10^{-4}$ | 1.0 | $4.5 \times 10^{-4}$ | 0.02 |
| Simplified Boiling Water Reactor | 0.12 | 2.0 | $7.6 \times 10^{-6}$ | $2.2 \times 10^{-6}$ | $2.8 \times 10^{-4}$ | 2.1 | $9.5 \times 10^{-4}$ | 0.042 |
| AP600 | 0.29 | 3.0 | $2.3 \times 10^{-5}$ | $6.6 \times 10^{-6}$ | $7.7 \times 10^{-4}$ | 3.3 | $1.5 \times 10^{-3}$ | 0.066 |

[a] Background dose to the population within 50 miles plus the people who use the Savannah River for drinking water at the Port Wentworth and Beaufort-Jasper (person-rem): 260,000 person-rem in year 2030.
Source: HNUS 1995a.

## E.3 Hazardous Chemical Impacts to Human Health

### E.3.1 Background

There are two types of adverse health effects normally assessed for hazardous chemical exposure. These are carcinogenic and noncarcinogenic effects. For this reason, two kinds of tables were developed (i.e., a table for chemical toxicity profiles (E.3–1) and a table of exposure limits (E.3–2)). Table E.3–1 characterizes each chemical (either found at the site or associated with tritium supply and recycling) qualitatively so that the risk assessor can determine how exposure might occur (e.g., route of exposure), what effect might occur (e.g., central nervous system dysfunction), and whether the chemical might possess other properties that might affect its bioavailability in a given matrix (e.g., air, water, or soil). Table E.3–2 provides the risk assessor with the necessary information to calculate the risk or expected adverse effects that would be expected when an individual is exposed to a hazardous chemical for a long term at low levels (chronic exposure) or to higher concentrations for a short term (acute) exposure. Where a dose effect calculation is required (mg/kg/day), the Reference Dose is applicable and where an inhaled concentration effect is required, the Reference Concentration ($mg/m^3$) is applicable for chronic exposures. The Permissible Exposure Limit, Threshold Limit Value, Short Term Exposure Limit, and Reference Exposure Limit values regulate worker exposures over short-term (e.g., 15-min to 8-hr) exposures that are allowed for these time intervals without adverse acute effects.

It was assumed that under normal operation conditions, members of the public would only receive chronic exposures at low levels from the air emissions from a centrally located source term at each site; because the chemicals are not released into water or soil, that exposure is entirely from inhalation. It was further assumed that the maximally exposed member of the public would be at the site boundary and this assumption was used for all public exposure calculations. For worker exposures to hazardous chemicals, it was assumed that individuals were exposed only to low air emission concentrations during an 8-hr day for a 40-hr week at a point 100 meters from a centrally located source term, since precise placement of source terms onsite cannot be made. Further, it cannot be determined where various workers would be relative to the emission sources.

For every site involved in the analyses, Hazard Indexes (HI) were calculated for all options relevant to the site. The concentrations of hazardous chemicals identified with each option have been developed by modeling each chemical concentration and individually comparing these concentrations to the Reference Concentration (unique to each chemical) to yield Hazard Quotients (HQ) and the HQs summed to yield the HIs for public exposure. For worker exposures, the concentrations are compared to the Permissible Exposure Limit (unique to each chemical) to yield HQs that are summed to yield HIs. The slope factors for all carcinogens are multiplied by the inhaled dose to determine the cancer risk. Table E.3–2 has all slope factors, Reference Concentrations, Reference Dose values, and Permissible Exposure Limits that were used in deriving HIs and cancer risks.

### E.3.2 Chemical Toxicity Profiles

Table E.3–1 provides the reader with pertinent facts about each chemical that will be included in the risk assessment. This includes the Chemical Abstracts Service number, which aids in a search for information available on any specific chemical and ensures a positive identity regardless of which name or synonym is used. It also contains physical information (i.e., solubility, vapor pressure, and flammability) as well as presenting incompatibility data that is useful in determining whether a hazard might exist and the nature of the hazard. The route of exposure, target organs, and carcinogenicity provide an abbreviated summary on how individuals may get exposed, what body functions could be affected, and whether chronic exposure could lead to cancer in an exposed population. Table E.3–1 presents the information described above for those chemicals for which adverse health effects were developed in this PEIS.

### E.3.3 Regulated Exposure Limits

Hazardous chemicals are regulated by various agencies to provide protection to the public (EPA) and workers (Occupational Safety and Health Administration (OSHA) and National Institute for

Occupational Safety and Health) while others (American Conference of Governmental Industrial Hygienists) provide guidelines. The Reference Dose and Reference Concentration set by EPA represent exposure limits for long-term (chronic) exposure at low doses and concentrations, respectively, that can be considered safe from adverse noncancer effects. The Permissible Exposure Limit represents levels set by OSHA that are considered safe for 8-hour exposures so as not to cause noncancer adverse effects. The slope factor for each toxic chemical can be used to convert the daily intake averaged over a lifetime of exposure to the incremental risk of an individual developing cancer. Table E.3–2, presents the information on exposure limits that was used to develop HQs for individual hazardous chemicals, the HIs for each option at each site, and the slope factors used to calculate cancer risk for each chemical.

### E.3.4 Hazardous Chemical Risk/Effects Calculations

Tables E.3.4–1 through E.3.4–36 present the calculations of HIs and cancer risks for each option for public exposure and workers at all 5 sites. The table numbers correspond exactly to the summary tables appearing in the text, with the risks for all options appearing in the summary table.

TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 1 of 9]

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Acetic acid | 64-19-7 | Miscible[a] | 11 mm[a] | Class II | Strong oxidizers (esp. chromic acid, sodium peroxide and nitric acid), and strong caustics | inh | Respiratory system, skin, eyes, teeth | f |
| Acetone | 67-64-1 | Miscible[a] | 180 mm[a] | Class IB | Oxidizers, acids | inh, ing, con | Respiratory system, skin | f |
| Acetonitrile | 75-05-8 | Miscible[a] | 73 mm[a] | Class IB | Strong oxidizers | inh, abs, ing, con | Kidneys, liver, cardiovascular system, CNS, lungs, skin, eyes | e |
| Acetylene | 74-86-2 | Quite soluble in water | 40 atm[k] | Flammable | Brass and copper, salts, oxidants | inh[i] | Lungs (not serious) | f |
| Acrolein | 107-02-8 | 40%[a] | 210 mm[a] | Class IB | Oxidizers, acids, alkalis, ammonia, amines | inh, ing, con | Heart, eyes, skin, respiratory system | EPA Group C: Possible human carcinogen[g] |
| Acrylonitrile | 107-13-1 | 7%[a] | 83 mm[a] | Class IB | Strong oxidizers, acids, and alkalis, bromine amines | inh, ing, abs, con | CVS, liver, kidneys, CNS, skin, brain tumor, lung and bowel cancer | EPA Group B1: Probable human carcinogen; limited evidence in human studies[g] |
| Aliphatic alcohol (n-butyl alcohol) | 71-36-3 | 9%[a] | 6mm[a] | Class IC[a] | Strong oxidizers[a] | inh, abs[a], ing, con | Eyes, skin[a], respiratory system | f |
| Aliphatic hydrocarbons[e] (e.g., cyclohexane) | 107-13-1 | Insoluble | 98mm (77 °F) | Class IA | Oxidizers | inh, ing, con | Eyes, respiratory system, skin, CNS | f |
| Ammonia | 7664-41-7 | 34% in water at 68 °F[a] | >1 atm[a] | Combustible gas, but difficult to burn | Strong oxidizers, acids, halogens, salts of silver and zinc | inh, ing, con | Respiratory system, eyes | f |
| Antimony | 7440-36-0 | Insoluble | Approx. 0 mm | Noncombustible solid in bulk form, but a moderate explosion hazard in the form of dust when exposed to flame | Strong oxidizers acids, halogenated acids | inh, con | Respiratory system, CVS, skin, eyes | EPA Group A based on radionuclide carcinogenicity |
| Aromatic petroleum distillate (benzo[a]pyrene) | 50-32-8 | Insoluble[l] in water | q | q | e | inh, ing[l] | Respiratory system[l], skin | EPA Group $B_2$ : Probable human carcinogen |

**TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 2 of 9]**

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Aromatic hydrocarbons | | | | | | | | |
| benzo (a) pyrene | 50-32-8 | Insoluble | e | e | e | ing, inh[l] | Skin, respiratory, liver, intestine, colon[l] | EPA Group B2 |
| chrysene | 218-01-9 | Insoluble | e | e | e | ing, inh[l] | | EPA Group B2 |
| pyrene | 129-00-0 | Insoluble | e | e | e | inh, ing[j] | Kidney[l] | EPA Group D |
| Benzene | 71-43-2 | 0.07%[a] | 75 mm[a] | Class IB | Strong oxidizers, many fluorides and perchlorates, nitric acid | inh, abs, ing, con | Blood, CNS, skin, bone marrow, eyes, respiratory system | EPA Group A: Human carcinogen[g] |
| Bromoform | 75-25-2 | 0.1%[a] | 5mm[a] | Noncombustible | Lithium, sodium potassium, calcium, aluminum, zinc, magnesium, strong caustics, acetone | inh, abs, ing | Skin, liver, kidneys, respiratory system, CNS | EPA Group B2: Probable human carcinogen; sufficient evidence from animal studies, inadequate evidence or no data from human studies[g] |
| 2-Butoxyethanol | 111-76-2 | Miscible[a] | 0.8mm[a] | Class IIIA[a] | e | inh, abs[a], ing, con | Liver, kidney[a], lymphoid system skin, blood, eyes, respiratory system | f |
| n-Butyl acetate | 123-86-4 | 1.0%[a] | 15 mm[l] (77 °F) | Class IC | Nitrates; strong oxidizers, alkalis, acids | inh, ing, con | Eyes, skin, respiratory system | f |
| n-Butyl alcohol | 71-36-3 | 9.0%[a] | 6 mm[a] | Class IC | Strong oxidizers[a] | inh, abs, ing, con | Skin, eyes, respiratory system[a] | f |
| Cadmium | 7440-43-9 | Insoluble[a] | Approx 0 mm[a] | Noncombustible solid in bulk form, but will burn in powder form | Strong oxidizers; elemental sulfur, selenium, and tellurium | inh, ing | Respiratory system, kidneys, prostate, blood | EPA Group B1: Probably human carcinogen; limited evidence in human studies[g] |
| Cadmium oxide | 1306-19-0 | Insoluble[a] | Approx 0 mm[a] | Noncombustible | e | inh | Respiratory system, kidneys, blood | f |
| Carbon tetrachloride | 56-23-5 | 0.05%[a] | 91 mm[a] | Noncombustible | Chemically-active metals such as sodium, potassium and magnesium; fluorine; aluminum; Note: forms highly toxic phosgene gas when exposed to flames or welding arcs | inh, abs, ing, con | CNS, eyes, lungs, liver, kidneys, skin | EPA Group B2: Sufficient evidence in animals, no data for humans |

TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 3 of 9]

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Chlorine | 7782-50-5 | 0.7%[a] | >1 atm[a] | Noncombustible gas, but a strong oxidizer | Reacts explosively or forms explosive compounds with many common substances such as acetylene, ether, ammonia | inh, con | Respiratory system | [f] |
| Chlorobenzene | 108-90-7 | 0.05%[a] | 12 mm (77 °F)[a] | Class IC | Strong oxidizers | inh, ing, con | Respiratory system, eyes, skin, CNS, liver | EPA Group D: Not classified as to human carcinogenicity[g] |
| Chlorodifluoromethane (Freon 22) | 75-45-6 | c | c | Nonflammable[l], combustible | [e] | inh[m] | Respiratory[j] system, CNS, liver, kidney, spleen | EPA Group C:[i] Possible human carcinogen |
| Chloroform | 67-66-3 | 0.5% (77 °F)[a] | 160 mm[a] | Noncombustible | Strong caustics, chemically active metals (aluminum or magnesium powder, sodium and potassium), strong oxidizers | inh, ing, con | Liver, kidneys, heart, eyes, skin | EPA Group B2: Probable human carcinogen; sufficient evidence from animal studies, inadequate evidence or no data from human studies[g] |
| Cleaning solvent (butyl lactate) | 138-22-7 | Slightly soluble in water | 0.4 tors (20 °C) | Autoignition at 382.2 °C | [e] | inh | Respiratory system | [f] |
| Cyanogen | 460-19-5 | NA | 1.8mm[l] | Flammable[l] Lower explosive limit = 6.6% Upper limit = 32% | [e] | inh, con[l] | Respiratory[l] system, eyes | [f] |
| Cyclohexane | 110-82-7 | Insoluble[a] | 98 mm (77 °F)[a] | Class IA | Oxidizers | inh, ing, con | Eyes, respiratory system, skin, CNS | [f] |
| Diacetone alcohol | 123-42-2 | Miscible[a] | 1mm[a] | Class II[a] | [e] | inh, abs[a], ing | Liver, respiratory[a] system, CNS depression, eyes | [f] |
| Dibutyl phthalate | 84-74-2 | 0.5% (77 °F)[a] | <0.01 mm[a] | Class IIIB | Nitrates; strong oxidizers, alkalis and acids; liquid chlorine | inh, ing, con | Respiratory system, GI tract | EPA Group D: Not classified as to human carcinogenicity[g] |
| 1,3-Dichloropropene | 542-75-6 | [e] | 28 tors (20 °C) | 28.3 to 3.5 °C Flash-point explosive limits: 5 to 145% in air | [e] | inh, con | Eyes, lung, kidney, liver | EPA Group B2: Probable human carcinogen; sufficient evidence from animal studies, inadequate evidence or no data from human studies[g] |

**TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 4 of 9]**

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Diethylene glycol ethyl ether | 111-90-0 | NA | 4.62mm[l] | Flash Pt.[l] 201° F | [e] | ing, abs[l], con | Skin, eyes[l] | [f] |
| Dimethylformamide | 68-12-2 | Miscible[a] | 4 mm[a] (77 °F) | Class IIIA | Carbon tetrachloride, other halogenated compounds when in contact with iron; strong oxidizers; alkyl aluminum; inorganic nitrates | inh, abs, ing, con | Liver, kidneys, CNS, skin | [f] |
| Dioctyl phthalate | 117-81-7 | Insoluble[a] | >0.01 mm[a] | Class IIIB | Nitrates; strong oxidizers, acids and alkalis | inh, con, ing | Eyes, upper respiratory system, GI tract | EPA Group B2: Sufficient evidence in animals, no data for humans |
| 2,4-Dinitrotoluene | 121-14-2 | Insoluble[a] | 1.0 mm | Combustible solid, but difficult to ignite | Strong oxidizers, caustics, metals such as tin and zinc | inh, abs, ing, con | Blood, liver, CVS | EPA Group B2: (For mixture)[g] |
| Epoxy solvent (e.g., toluene) | 108-88-3 | 0.05%[a] at 61° F | 20mm[a] at 65° F | Class IB[a] | Strong oxidizers | inh, abs[a], ing, con | CNS, liver[a], kidneys, skin | [f] |
| Ethyl acetate | 141-78-6 | 10% (77 °F)[a] | 74 mm[a] | Class IB | Nitrates; strong oxidizers, alkalis and acids | inh, ing, con | Eye, skin, respiratory system | [f] |
| Ethyl benzene | 100-41-4 | 0.01%[a] | 10 mm (79 °F)[a] | Class IB | Strong oxidizers | inh, ing, con | Eyes, upper respiratory system, skin, CNS | EPA Group D: Not classifiable as to human carcinogenicity[g] |
| Ethanol | 64-17-5 | Miscible with water and most organic solvents | 43 tors (20 °C) | Class IA | | inh, ing | Liver, kidney | None |
| Ethylene oxide | 75-21-8 | Miscible[a] | >1 atm[a] | Class IA | Strong acids, alkalis and oxidizers; chlorides of iron, aluminum and tin; oxides of iron and aluminum | inh, ing, con | Eyes, blood, respiratory system, liver, CNS, kidneys | IARC Group 2A: Suspect human carcinogens, inadequate evidence in humans, adequate evidence in animals (EPA Group B2)[l] |
| Formaldehyde | 50-00-1 | Miscible[a] | >1 atm/ 1 mm[a] | Class IIIB | Strong oxidizers, alkalis and acids; phenols; urea; pure formaldehyde has a tendency to polymerize | inh, ing, con | Respiratory system, eyes, skin | EPA Group B1: Sufficient evidence in animals, limited evidence in humans[g] |
| Formic acid | 64-18-6 | Miscible[a] | 35 mm[a] | Class IIIA | Strong oxidizers, strong caustics, concentrated sulfuric acid | inh, ing, con | Respiratory system, skin, kidneys, liver, eyes | |

**TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 5 of 9]**

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Freon 22 (chloro-difluoromethane) | 75-45-6 | e | e | Nonflammable[l] | e | inh[m] | Respiratory, CNS, liver, kidney, spleen[j] | Human Evidence Inadequate, Animal evidence limited[i] |
| Freon 12 (dichloro-difluoromethane) | 75-71-8 | 0.03% (77 °F)[a] | >1 atm[a] | Nonflammable gas | Chemically active metals (i.e., sodium, potassium, calcium, powdered aluminum, zinc and magnesium)[a] | inh, con | Cardiovascular system, peripheral nervous system | f |
| Freon 114 (dichloro-tetrafluoroethane) | 76-14-2 | 0.01%[a] | >1 atm[a] | Nonflammable gas | Chemically active metals (i.e., sodium, potassium, calcium, powdered aluminum, zinc and magnesium; acids; acid fumes | inh, ing, con | Respiratory system, cardiovascular system | f |
| Freon 11 (trichloro-fluoromethane) | 75-69-4 | 0.1010 (77 °F)[a] | 690 mm[a] | e | Sodium, potassium, aluminum, calcium, lithium, barium | inh, ing, con | CVS, skin | f |
| Freon 113 (trichloro-trifluoroethane) | 76-13-1 | 0.02%[a] (77 °F) | 285 mm[a] | Flammable | Aluminum, barium, lithium, samarium, sodium, potassium alloy, titanium | inh, ing, con[l] | CNS, skin | f |
| Freon TF (trichloro-trifluoromethane) | 75-69-4 | 0.1%[a] at 77° F | 690mm[a] | N/A[a] | Aluminum, barium, lithium, samarium, sodium, potassium alloy, titanium | inh, ing[a], con | CNS, skin[a] | f |
| Heptane | 142-82-5 | 0.005% (60 °F)[a] | 40 mm (72 °F)[a] | Class IB | Strong oxidizers | inh, ing, con | Skin, respiratory system, peripheral nervous system | Class D |
| Hexane | 110-54-3 | 0.002%[a] | 150 mm (77 °F)[a] | Class IB | Strong oxidizers | inh, ing, con | Skin, eyes, respiratory system | EPA Group D: Not classifiable as to human carcinogenicity[g] |
| Hydrocarbons (n-heptane) | 142-82-5 | .005%[a] at 60° F | 40mm[a] at 72° F | Class IB[a] | Strong oxidizers | inh, ing[a], con | Skin, respiratory[a] system, peripheral nervous system | EPA Group D: Not classifiable as to human carcinogenicity |
| Hydrochloric acid | 7647-01-0 | 67% (87 °F)[a] | >1 atm[a] | Nonflammable gas | Metals, hydroxides, amines, alkalis; corrosive to most metals | inh, ing, con | Respiratory system, skin, eyes | f |
| Hydrofluoric acid | 7664-39-3 | Miscible[a] | >1 atm[a] | Nonflammable gas | Metals, water or steam; corrosive to metals | inh, abs, ing, con | Eyes, respiratory system, skin | f |

**TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 6 of 9]**

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Hydrogen cyanide | 74-90-8 | Miscible[a] | 630mm[a] | Class IA[a] | NA | inh, abs[a], ing, con | CNS[a], cardiovascular, liver, kidneys | f |
| Hydrogen sulfide | 7783-06-4 | 0.4%[a] | >1 atm[a] | Flammable gas | Strong oxidizers, strong nitric acid, metals | inh, ing, con | Respiratory system, eyes | f |
| Isobutane (2-methyl propane) | 75-28-5 | NA | 2.01mm[p] | Lower[p] flammability limit = 1.8% Upper limit = 48% | e | inh[a] | Respiratory[p] system | f |
| Isobutyl acetate | 110-19-0 | 0.6%[a] at 77° F | 13mm[a] | Class IB[a] | e | inh, ing[a], con | Skin, eyes[a], respiratory system | f |
| Isopropyl alcohol | 67-63-0 | Miscible | 33 mm[a] | Class IB | Strong oxidizers, acetaldehyde, chlorine, ethylene oxide, acids, isocyanates | inh, ing, con | Eyes, respiratory system, skin | f |
| Manganese | 7439-96-5 | Insoluble[a] | Approx 0 mm[a] | Combustible solid | Oxidizers | inh, ing | Respiratory system, CNS, blood, kidneys | EPA Group D: Not classifiable as to human carcinogenicity[g] |
| Mercury (vapor) | 7439-97-6 | Insoluble[a] | 0.0012 mm | Noncombustible liquid | Acetylene, ammonia, chlorine dioxide, azides, calcium, sodium carbide, lithium, rubidium, copper | inh, abs, con | Skin, respiratory system, CNS, kidneys, eyes | f |
| Methane | 74-828 | NA | NA | NA | NA | inh | Lungs | f |
| Methanol | 67-56-1 | Miscible[a] | 92 mm[a] | Class IB | Strong oxidizers | inh, abs, ing, con | Eyes, skin, CNS, GI tract | f |
| Methyl bromide | 74-83-9 | 2%[a] | >1 atm[a] | Flammable gas but only in the presence of a high energy ignition source | Aluminum, magnesium, strong oxidizers | inh, abs, ing, con | CNS, respiratory system, skin, eyes | f |
| Methylene chloride | 75-09-2 | 2%[a] | 350 mm[a] | Combustible liquid | Strong oxidizers; caustics; chemically-active metals such as aluminum, magnesium, powders, etc. | inh, ing, con | Skin, CVS, eyes, CNS | EPA Group B2: Sufficient evidence in animals, limited evidence in humans[g] |
| Methyl ethyl ketone (2-butanone) | 78-93-3 | 28%[a] | 71 mm[a] | Class IB | Strong oxidizers, amines, ammonia, inorganic acids, caustics, copper, isocyanates, pyridines | inh, ing, con | CNS, lungs | EPA Group D: Not classifiable as to human carcinogenicity[n] |

TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 7 of 9]

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Methyl isobutyl ketone | 108-10-1 | 2%[a] | 16 mm[a] | Class IB | Strong oxidizers, potassium tertbutoxide | inh, ing, con | Respiratory system, eyes, skin, CNS | [e] |
| Methyl-tert-butyl-ether (2-methoxy-2-methyl-propane) | 1634-04-4 | 4%[k] | 245mm[k] | Ignition at 224 °C[k] | Unstable in acid solutions[k] | inh[k] | [e] | EPA Group D: Not classifiable as to human carcinogenicity[g] |
| Naphtha | 8030-30-6 | Insoluble[a] | <5 atm[a] | Class II | Strong oxidizers | inh, ing, con | Respiratory system, eyes, skin | [e] |
| Napthalene | 91-20-3 | 0.003%[a] | 0.08 mm[a] | Combustible solid, but will take effort to ignite | Strong oxidizers, chronic anhydride | inh, abs, ing, con | Eyes, blood, liver, kidneys, skin, RBC, CNS | EPA Group D: Not classifiable as to human carcinogenicity[g] |
| Nickel (refinery dust) | 7440-02-0 | Insoluble[a] | Approx 0 mm[a] | Noncombustible solid in bulk form | Strong acids, sulfur, selenium, wood and other combustibles, nickel nitrate | inh, ing, con | Lungs, paranasal sinus, CNS | Nickel refinery dust-EPA Group A: Human carcinogen[g] |
| Nitric acid | 7697-37-2 | Miscible[a] | 48 mm[a] | Noncombustible liquid, but increases flammability of combustible materials | Combustible materials; metallic powders; hydrogen sulfide, carbides; alcohols | inh, ing, con | Eyes, respiratory system, skin, teeth | [f] |
| Nitrocellulose (cellulose tetranitrite) | 9004-70-4 | NA | NA | NA | NA | NA | NA | [f] |
| Perfluoroalkylether (isoflurane) | 26675-46-7 | NA | NA | NA | [e] | inh[q] | Respiratory[q] system, CNS | [f] |
| Perfluoro compounds (e.g., tetra CFCs) | 76-14-2 | 0.1%[a] | >1 Atm[a] | Nonflammable[a] | Chemically active metals | inh, ing[a], con | Respiratory[a] system, cardiovascular | [f] |
| Phenol | 108-95-2 | 9% (77 °F)[a] | 0.4 mm[a] | Combustible solid | Strong oxidizers, calcium hypochlorite, aluminum chloride, acids | inh, abs, ing, con | Liver, kidneys, skin | EPA Group D: Not classifiable as to human carcinogenicity[g] |
| Phosphoric acid | 7664-38-2 | Miscible[a] | 0.03 mm[a] | Noncombustible liquid | Strong caustics, most metals | inh, ing, con | Respiratory system, eyes, skin | [f] |
| Propane | 74-98-6 | 0.01%[a] | >1 Atm[a] | Lower limit 2%[p] Upper limit 52% | [e] | inh, con[a] | CNS[a] | [f] |
| Propyl glycol methyl ether (propylene glycol monomethyl ether) | 107-98-2 | NA | NA | NA | [e] | ing, con[l] | Skin[l] | [f] |
| Propylene dichloride | 78-87-5 | 0.3%[a] | 40 mm[a] | Class IB | Strong oxidizers, strong acids | inh, con, ing | Skin, eyes, respiratory system, liver, kidneys | EPA Group C: Possible human carcinogen[o] |

**TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 8 of 9]**

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Resins and formers (toluene-2,4-diisocyanate) | 584-84-9 | Insoluble[a] | 0.01mm[a] at 77° F | Class IIIB[a] | e | inh, ing[a], con | Respiratory[a] system, skin | f |
| Sodium hydroxide | 1310-73-2 | 111%[a] | Approx 0 mm[a] | Noncombustible solid, but when in contact with water may generate enough heat to ignite combustible materials | Water, acids, flammable liquids, organic halogens, metals (aluminum, tin, and zinc), nitromethane | inh, ing, con | Eyes, respiratory system, skin | f |
| Sulfuric acid | 7664-93-9 | Miscible[a] | 1 mm (295 °F)[a] | Noncombustible liquid, but can ignite finely divided combustible metals | Organic materials, chlorates, carbides, fulminates, water, powdered metals; corrosive to metals | inh, ing, con | Respiratory system, eyes, skin, teeth | f |
| Tetrachloroethane (1,1,2,2) | 79-34-5 | 0.3%[a] | 9 mm (86 °F)[a] | Noncombustible liquid[k] | Chemically-active metals, strong caustics, fume of sulfuric acid | inh, abs, ing, con | liver, kidneys, CNS | EPA Group C: Possible human carcinogen[g] |
| Tetrahydrofuran | 109-99-9 | Miscible[a] | 23mm[a] | Class IB[a] | e | inh, ing[a], con | Eyes, skin, CNS[a], respiratory system | f |
| Toluene | 108-88-3 | 0.05%[a] | 20 mm[a] (65 °F) | Class IB | Strong oxidizers | inh, abs, ing, con | CNS, liver, kidneys, skin | f |
| Trichloroethane (1,1,1) | 71-55-6 | Insoluble[k] | e | Noncombustible liquid[k] | e | inh[k] | CNS, eyes, mucus membrane[k] | f |
| Trichloroethylene | 79-01-6 | 0.1% (77 °F)[a] | 58 mm | Class IC | Strong caustics and alkalis; chemically-active metals such as barium, lithium, sodium, magnesium, titanium, and beryllium | inh, ing, con | Respiratory system, heart, liver, kidneys, CNS, skin | EPA Group B: Sufficient evidence in animals, inadequate evidence in humans[n] |
| Uranium | 7440-61-1 | Insoluble[a] | Approx 0 mm[a] | Combustible solid, esp. turnings and powder | Carbon dioxide, carbon tetra-chloride, nitric acid, fluorine | inh, con, ing | Skin, bone marrow, lymphatics | EPA Group A: Human Carcinogen[n] |
| Vinyl acetate | 108-05-4 | Somewhat soluble in water[m] | 100[n] | Flammable liquid[m] | Oxygen[n], hydrogen peroxide | inh, con[m] | Skin, eye[m] | EPA Group D: Inadequate evidence in animals[o] |
| Vinyl chloride | 75-01-4 | 0.1% (77 °F)[a] | >1 atm[a] | Flammable gas | Copper, oxidizers, aluminum, peroxides, iron, steel | inh | Liver, CNS, blood, respiratory system, lymphatic system | EPA Group A: Human Carcinogen[o] |

**TABLE E.3–1.—*Chemical Toxicity Profiles* [Page 9 of 9]**

| Compound | Chemical Abstracts Service No.[a] | Solubility | Vapor Pressure | Flammability[a,b] | Incompatibilities[a] | Route of Exposure[a,c] | Target Organs[a] | Carcinogenicity[d] |
|---|---|---|---|---|---|---|---|---|
| Xylene (o-, m-, p-isomers) | 1330-20-7 | Insoluble[a] | 7/9/9 mm[a] | IB (o-) IC (m-, p-) | Strong oxidizers | inh, abs, ing, con | CNS, eyes, GI tract, blood, liver, kidneys, skin[a] | [f] |

[a] NIOSH 1990a; ORNL 1993b.
[b] Flammable liquids are classified by OSHA (29 CFR 1910.106) as follows:
Class IA–Fl.P below 73 °F and BP below 100 °F;
Class IB–Fl.P below 73 °F and BP at or above 100 °F;
Class IC–Fl.P at or above 73 °F and below 100 °F;
Class II–Fl.P at or above 100 °F and below 140 °F;
Class IIIA–Fl.P at or above 140 °F and below 200 °F;
Class IIIB–Fl.P at or above 200 °F.
[c] Routes of exposure abbreviated as follows:
inh–inhalation;
abs–skin absorption;
ing–ingestion;
con–skin and/or eye contact.
[d] DHHS 1992a.
[e] Information is not available.
[f] Not applicable.
[g] ORNL 1993b.
[h] Mixture of compounds, therefore, a representative compound was selected for chemical group.
[i] DHHS 1992b.
[j] ACGIH 1991.
[k] Merck 1989a.
[l] Lewis 1992a.
[m] DHHS 1986a.
[n] EPA 1993c.
[o] CFR 40, EPA 1992.
[p] Patty's Industrial Hygiene and Toxicology
[q] Moderate explosion hazard in form of dust when exposed to flame.

Note: CNS - central nervous system

Note: CVS - cardiovascular system

**TABLE E.3–2.—*Table of Exposure Limits* [Page 1 of 9]**

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Acetic acid | 64-19-7 | 0.175[b] | 0.613[c] | NA | None | OSHA-PEL: 25 $mg/m^3$[d]<br>ACGIH-TLV: 25 $mg/m^3$, 37 $mg/m^3$ [STEL][e]<br>NIOSH-REL: same as above[f] |
| Acetone | 67-64-1 | $1x10^{-1}$ | 10.5 (PNL) | D | None | OSHA-PEL: 1,800 $mg/m^3$ and STEL of 2,400 $mg/m^3$[d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: 590 $mg/m^3$ and a IDLH of 48,400 $mg/m^3$[d] |
| Acetonitrile | 75-05-8 | $6.0x10^{-3}$ | 0.002[c]<br>[0.050*] | NA | None | OSHA-PEL: 70 $mg/m^3$, 105 $mg/m^3$ [15-min. STEL][d]<br>ACGIH-TLV: 67 $mg/m^3$, 101 $mg/m^3$ [skin] [STEL][e]<br>NIOSH-REL: 34 $mg/m^3$[d] |
| Acetylene | 74-86-2 | 18.96[c] | 66.28[c] | NA | None | OSHA-PEL: 2,708 $mg/m^3$[f]<br>ACGIH-TLV: Simple Asphyxiant<br>NIOSH-REL: 2,708$mg/m^3$[f] |
| Acrolein | 107-02-8 | $2x10^{-2}$* | $2x10^{-5}$ | C | None | OSHA-PEL: 0.25 $mg/m^3$ and STEL of 0.8 $mg/m^3$[d]<br>ACGIH-TLV: 0.23 $mg/m^3$[c]<br>NIOSH-REL: Same as OSHA, IDLH = 11.65 $mg/m^3$[d] |
| Acrylonitrile | 107-13-1 | $1x10^{-3}$* | $2x10^{-3}$[k] | $B_1$[k] | 0.24 (inhal) | OSHA-PEL: 4.42 $mg/m^3$<br>ACGIH-TLV: 4.3 $mg/m^3$<br>NIOSH: IDLH = 1,105 $mg/m^3$ |
| Aliphatic alcohol (n-butyl alcohol) | 71-36-3 | 0.1[j] | 0.35[p,b] | D | None | OSHA-PEL: 150 $mg/m^3$ (skin)<br>ACGIH-TLV: 152 $mg/m^3$ (ceiling)<br>NIOSH-REL: 150 $mg/m^3$ (skin) (ceiling) |
| Aliphatic hydrocarbons (e.g., cyclohexane) | 107-13-1 | 7.36* | 25.7[f] | NA | None | OSHA-PEL: see cyclohexane[f]<br>ACGIH-TLV: see cyclohexane[f]<br>NIOSH-REL: see cyclohexane[f] |
| Ammonia | 7664-41-7 | None | $1x10^{-1}$ | NA | None | OSHA-PEL: 27 $mg/m^3$[d]<br>ACGIH-TLV: 17 $mg/m^3$ and a 15 minute STEL of 27 $mg/m^3$[d]<br>NIOSH-REL: 18 $mg/m^3$ and a 15 minute STEL of 27 $mg/m^3$[d] |
| Antimony | 7440-36-0 | $4x10^{-4}$* | $139x10^{-5}$[c] | NA | None | OSHA-PEL: 0.5 $mg/m^3$[d]<br>ACGIH-TLV: 0.5 $mg/m^3$[e]<br>NIOSH-REL: 0.5 $mg/m^3$ and IDLH of 80 $mg/m^3$[d] |
| Aromatic hydrocarbons | | | | | | |
| benzo (a) pyrene | 50-32-8 | NA | NA | B2k | 5.79 | OSHA-PEL: 0.2 $mg/m^3$ |
| Chrysene | 218-01-9 | NA | NA | B2k | | ACGIH-TLV: suspected human carcinogen |
| Pyrene | 129-00-0 | $3x10^{-2}$ | 1.05x10-1[c] | Dk | | NIOSH-REL: controlled as a carcinogen |

TABLE E.3–2.—*Table of Exposure Limits* [Page 2 of 9]

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Aromatic petroleum distillate (benzo[a]pyrene) | 50-32-8 | $1.4x10^{-4}$ [1,b] | $4x10^{-5}$ [c] | $B_2$ | 5.79 | OSHA-PEL: 0.2 $mg/m^3$<br>ACGIH-TLV: Suspect Human Carcinogen<br>NIOSH-REL: Controlled as Carcinogen |
| Benzene | 71-43-2 | 0.224[b] | 0.783[c] | A | .029 (oral) | OSHA-PEL: 3.25 $mg/m^3$ and a STEL of 16.25<br>ACGIH-TLV: 32 $mg/m^3$<br>NIOSH-REL: 0.325 $mg/m^3$ and a IDLH of 9750 $mg/m^3$ |
| Bromoform | 75-25-2 | $2x10^{-2}$ | $6.99x10^{-4}$ | $B_2$[k] | 0.0039 | OSHA-PEL: 5 $mg/m^3$[d]<br>ACGIH-TLV: 5.2 $mg/m^3$[e]<br>NIOSH-REL: 5 $mg/m^3$[d] |
| 2-Butoxyethanol | 111-76-2 | $8.47x10^{-1}$ [b] | 2.96[c] | NA | None | OSHA-PEL: 240 $mg/m^3$<br>ACGIH-TLV: 121 $mg/m^3$<br>NIOSH-REL: 120 $mg/m^3$ |
| n-Butyl acetate | 123-86-4 | 4.97[b] | 17.4[c] | NA | None | OSHA-PEL: 710 $mg/m^3$, 950 $mg/m^3$ [15-min. STEL][g]<br>ACGIH-TLV: same as above[h]<br>NIOSH-REL: same as above[f] |
| n-Butyl alcohol | 71-36-3 | $1x10^{-1}$ | 0.35[c] | D | None | OSHA-PEL: 150 $mg/m^3$ [skin] [ceiling][d]<br>ACGIH-TLV: 152 $mg/m^3$ [ceiling][e]<br>NIOSH-REL: 150 $mg/m^3$ [skin] [ceiling][d] |
| Cadmium | 7440-43-9 | $5x10^{-4}$ | $5x10^{-4}$ | $B_1$ | [i] | OSHA-PEL: 0.2 $mg/m^3$[d]<br>ACGIH-TLV: 0.05 $mg/m^3$[e]<br>NIOSH-IDLH: 50 $mg/m^3$[d] |
| Cadmium oxide | 1306-19-0 | $7x10^{-3}$ | $2.5x10^{-3}$ | NA | None | OSHA-PEL: 0.1 $mg/m^3$[d]<br>ACGIH-TLV: 0.05 $mg/m^3$[e]<br>NIOSH-REL: 2 $mg/m^3$ and an IDLH of 9 $mg/m^3$[d] |
| Carbon tetrachloride | 56-23-5 | $7x10^{-4}$ | $2.5x10^{-3}$ | $B_2$ | $1.3x10^{-1}$ (oral)*<br>$5.3x10^{-2}$ (inhal)* | OSHA-PEL: 12.6 $mg/m^3$ [8-hr TWA][d]<br>ACGIH: 32 $mg/m^3$ [skin][h]<br>NIOSH-REL: 12.6 $mg/m^3$ [60-min ceiling limit][d] |
| Chlorine | 7782-50-5 | 0.011[b] | $3.9x10^{-2}$ [PNL] | NA | None | OSHA-PEL: 1.5 $mg/m^3$ and a 15-minute STEL of 3 $mg/m^3$[d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: same as above[d] |
| Chlorobenzene | 108-90-7 | $2x10^{-2}$ | $2x10^{-2}$* (alternate method) | D | None | OSHA-PEL: 350 $mg/m^3$[d]<br>ACGIH-TLV: 46 $mg/m^3$[e]<br>NIOSH-IDLH: 11,232 $mg/m^3$[d] |

TABLE E.3–2.—*Table of Exposure Limits* [Page 3 of 9]

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Chlorodifluoromethane (Freon 22) | 75-45-6 | 27.796[b] | 86.7[c] | NA | None | OSHA-PEL: 3,500 $mg/m^3$<br>ACGIH-TLV: 3,540 $mg/m^3$<br>NIOSH-REL: NA |
| Chloroform | 67-66-3 | $1x10^{-2}$ | .03497 | $B_2$ | 0.0061 (oral)<br>0.08 (inhal) | OSHA-PEL: 240 $mg/m^3$[g]<br>OSHA-TWA: 9.78 $mg/m^3$[d]<br>ACGIH-TLV: 49 $mg/m^3$[e]<br>NIOSH-IDLH: 4,960 $mg/m^3$[d] |
| Cleaning solvent (butyl lactate) | 138-22-7 | 0.208[b] | 0.73[c] | NA | NA | OSHA-PEL: 30 $mg/m^3$[g]<br>ACGIH-TLV: 30 $mg/m^3$[e] |
| Cyanogen | 460-19-5 | $7x10^{-1}$ [l] | $2.45x10^{-1}$ [c] | NA | None | OSHA-PEL: NA<br>ACGIH-TLV: 21 $mg/m^3$<br>OSHA-TWA: 20 $mg/m^3$ |
| Cyclohexane | 110-82-7 | 7.35[b] | 25.7[f] | NA | None | OSHA-PEL: 1,050 $mg/m^3$[f]<br>ACGIH-TLV: 1,030 $mg/m^3$[f]<br>NIOSH-REL: 1,050 $mg/m^3$[f] |
| Diacetone alcohol | 123-42-2 | 1.68[l] | 5.88[c] | NA | None | OSHA-PEL: 240 $mg/m^3$<br>ACGIH-TLV: 240 $mg/m^3$<br>NIOSH-REL: 240 $mg/m^3$ |
| Dibutyl phthalate | 84-74-2 | 0.1 | 0.3497 | D | None | OSHA-PEL: 5 $mg/m^3$[d]<br>ACGIH-TLV: 5 $mg/m^3$[e] |
| Dichloropropene (1,3) | 542-75-6 | $3x10^{-4}$ | $2x10^{-2}$ | $B_2$ | 0.18 | OSHA-PEL: 5 $mg/m^3$[g]<br>ACGIH-TLV: 4.5 $mg/m^3$[e] |
| Diesel exhaust | [i] | [i] | [i] | [i] | [i] | OSHA-PEL: [i]<br>ACGIH-TLV:[i]<br>NIOSH-REL:[i] |
| Diethylene glycol ethyl ether | 111-90-0 | $1.0x10^{-1}$ [m] | $3.5x10^{-1}$ [c] | NA | None | OSHA-PEL: NA<br>ACGIH-TLV: NA<br>RTECS: 2,500 mg/kg (rabbit) |
| Dimethylformamide | 68-12-2 | 0.112[b,h] | $3x10^{-2}$ | NA | None | NIOSH-REL: 30 $mg/m^3$ [8-hr TWA][d]<br>OSHA-PEL: same as above[g]<br>ACGIH-TLV: same as above[e] |
| Dinitrotoluene (2,4) | 121-14-2 | $2x10^{-3}$ | $6.9x10^{-3}$ | $B_2$ (Mixture) | None | OSHA-PEL: 1.5 $mg/m^3$<br>ACGIH-TLV: 0.15 $mg/m^3$<br>NIOSH-REL: Reduce to lowest level |
| Dioctyl phthalate (Di(2-ethylhexyl) phthalate) | 117-81-7 | 0.02 | 0.07[c] | $B_2$ | 0.014 (oral) | OSHA-PEL: 5 $mg/m^3$, 10 $mg/m^3$ [15-min. STEL][d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: same as above[d] |

**TABLE E.3–2.—*Table of Exposure Limits* [Page 4 of 9]**

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Epoxy solvent (e.g., toluene) | 108-88-3 | $1.14 \times 10^{-1}$ [k] | $4.0 \times 10^{-1}$ [j] | NA | None | OSHA-PEL: 240 $mg/m^3$<br>ACGIH-TLV: 188 $mg/m^3$<br>NIOSH-REL: 375 $mg/m^3$ |
| Ethyl benzene | 100-41-4 | 0.1 | 1 | D | None | OSHA-PEL: 435 $mg/m^3$[d]<br>ACGIH-TLV: 434 $mg/m^3$[e]<br>NIOSH-REL: 435 $mg/m^3$[d] and an IDLH of 8,820 $mg/m^3$[d] |
| Ethyl acetate | 141-78-6 | 0.9<br>[9.0*] | 3.15[c] | NA | None | OSHA-PEL: 1,400 $mg/m^3$[d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: same as above[d] |
| Ethyl alcohol (ethanol) | 64-17-5 | 13.2[b] | 46.1[c] | NA | None | OSHA-PEL: 1,900 $mg/m^3$[g]<br>ACGIH-TLV: 1,880 $mg/m^3$[e] |
| Ethylene oxide | 75-21-8 | 0.0128 | 0.0447 | IARC<br>EPA $B_1$ | 0.35<br>(inhal) | OSHA-PEL: 1.83 $mg/m^3$[f]<br>ACGIH-TLV: 1.8 $mg/m^3$[e]<br>NIOSH-REL: 0.18 $mg/m^3$ and an IDLH of 1,464 $mg/m^3$[f] |
| Fiske 604 | i | i | i | i | i | OSHA-PEL: [i]<br>ACGIH-TLV: [i]<br>NIOSH-REL: [i] |
| Formaldehyde | 50-00-1 | $2 \times 10^{-1}$ | none | $B_1$ | $4.5 \times 10^{-2}$<br>(inhal)*<br>unit risk factor:<br>$1.3 \times 10^{-5}$<br>(inhal) | OSHA-PEL: 1 ppm with a 15 min. STEL of 2 ppm[d]<br>ACGIH-TLV: 1 ppm[e]<br>NIOSH-REL: 0.16 ppm with a 15 minute STEL of 0.1 ppm (Ceiling)[d] |
| Formic acid | 64-18-6 | 2 | 6.994 | NA | NA | OSHA-PEL: 9 $mg/m^3$[d]<br>ACGIH-TLV: 9.4 $mg/m^3$[e]<br>NIOSH-REL: 9 $mg/m^3$ and an IDLH of 57.3 $mg/m^3$[d] |
| Freon 22 (chlorodifluoromethane) | 75-45-6 | 24.8[b] | 86.7[c] | NA | None | OSHA-PEL: 3,540 $mg/m^3$[d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: 3,500 $mg/m^3$, 4375 $mg/m^3$ [15-min. STEL][d] |
| Freon 12 (dichlorodifluoromethane) | 75-71-8 | 0.2[b] | 0.7[c]<br>[0.2*] | NA | None | OSHA-PEL: 4,950 $mg/m^3$[d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: same as above[d] |
| Freon 11 (trichlorofluoromethane) | 75-69-4 | 0.3 | 1.05[c]<br>[0.7*] | NA | None | OSHA-PEL: 5,620 $mg/m^3$, 5620 $mg/m^3$ [ceiling][d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: same as above[d] |
| Freon 113 (trichlorotrifluoroethane) | 76-13-1 | $3 \times 10^{1}$ | 105[c] | NA | None | OSHA-PEL: 7,600 $mg/m^3$, 9500 $mg/m^3$ [ST][d]<br>ACGIH-TLV: 7,670 $mg/m^3$, 9590 $mg/m^3$ [STEL][e]<br>NIOSH-REL: 7,600 $mg/m^3$, 9500 $mg/m^3$ [STEL][f] |

**TABLE E.3–2.—*Table of Exposure Limits* [Page 5 of 9]**

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Freon TF (trichlorotrifluoromethane) | 75-69-4 | $3.0x10^{-1}$ [j] | 1.05[c] | NA | None | OSHA-PEL: 5,600 $mg/m^3$<br>ACGIH-TLV: 5,620 $mg/m^3$<br>NIOSH-REL: 5,600 $mg/m^3$ |
| Heptane | 142-82-5 | 11.5[b] | 40.1[c] | D | None | OSHA-PEL: 1,600 $mg/m^3$, 2000 $mg/m^3$ [STEL][d]<br>ACGIH-TLV: 1,640 $mg/m^3$, 2050 $mg/m^3$ [STEL][e]<br>NIOSH-REL: 350 $mg/m^3$, 1800 $mg/m^3$ [15-min. ceiling][f] |
| Hexane | 110-54-3 | $6x10^{-2}$[j] | 0.2 | D | None | OSHA-PEL: 1,800 $mg/m^3$[g]<br>ACGIH-TLV: 176 $mg/m^3$[e]<br>NIOSH-REL: 180 $mg/m^3$ and an IDLH of 17,900 $mg/m^3$[d] |
| Hydrocarbons (n-heptane) | 142-82-5 | 11.5[b] | 40.1[c] | D | None | OSHA-PEL: 2,000 $mg/m^3$<br>ACGIH-TLV: 1,640 $mg/m^3$<br>NIOSH-REL: 350 $mg/m^3$ |
| Hydrochloric acid | 7647-01-0 | $2x10^{-3}$[c] | $7x10^{-3}$[a] | NA | None | OSHA-PEL: 7 $mg/m^3$[h]<br>ACGIH-TLV: 7 $mg/m^3$ [ceiling][i]<br>NIOSH-REL: 7 $mg/m^3$[f] |
| Hydrofluoric acid | 7664-39-3 | 0.018[b] | 0.063[c] | NA | None | OSHA-PEL: 2.5 $mg/m^3$, 5 $mg/m^3$ [STEL][d]<br>ACGIH-TLV: 2.6 $mg/m^3$ [ceiling][i]<br>NIOSH-REL: 2.5 $mg/m^3$, 5 $mg/m^3$ [STEL][g] |
| Hydrogen cyanide | 74-90-8 | $2.0x10^{-2}$ [l] | $7.0x10^{-2}$ [c] | NA | None | OSHA-PEL: 11 $mg/m^3$<br>ACGIH-TLV: 11 $mg/m^3$<br>NIOSH-REL: 5 $mg/m^3$ |
| Hydrogen fluoride | 7664-39-3 | 0.018[b] | 0.063[c] | NA | None | OSHA-PEL: 2.5 $mg/m^3$, 5 $mg/m^3$, 15 STEL<br>ACGIH-TLV: 2.6 $mg/m^3$[e]<br>NIOSH-REL: 2.5 $mg/m^3$ and an IDLH of 24.9 $mg/m^3$ |
| Hydrogen sulfide | 7783-06-4 | $3x10^{-3}$[k] | $9x10^{-4}$[k] | NA | None | OSHA-PEL: 28.4 $mg/m^3$, the TWA is 14 $mg/m^3$[d]<br>ACGIH-TLV: 14 $mg/m^3$, and the STEL is: 21 $mg/m^3$[e]<br>NIOSH-REL: 15 $mg/m^3$, the IDLH is 426 $mg/m^3$[d] |
| Isobutane (2 methyl propane) | 75-28-5 | 10.01[o] | 35.035[c] | NA | None | OSHA-PEL: NA<br>ACGIH-TLV: NA<br>RTECS-TWA: 1,430 $mg/m^3$ |
| Isobutyl acetate | 110-19-0 | 4.9[o] | 17.15[c] | NA | None | OSHA-PEL: 300 $mg/m^3$<br>ACGIH-TLV: 700 $mg/m^3$<br>NIOSH-REL: 700 $mg/m^3$ |
| Isopropyl alcohol | 67-63-0 | 0.202[i] | 24.15 (PNL) | NA | None | OSHA-PEL: 980 $mg/m^3$ [8-hr TWA],[d] 1,225 $mg/m^3$, [15-min ST limit][d]<br>ACGIH-TLV: same as above[e]<br>NIOSH-REL: same as above[d] |

TABLE E.3–2.—*Table of Exposure Limits* [Page 6 of 9]

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Manganese | 7439-96-5 | 0.14 | $5x10^{-3}$ | D[k] | None | OSHA-PEL: 5 $mg/m^3$, TWA = 1 $mg/m^3$[d]<br>ACGIH-TLV: 2 $mg/m^3$[e]<br>NIOSH-REL: 1 $mg/m^3$[d] |
| Mercury (vapor) | 7439-97-6 (mercury, inorganic) | $3x10^{-4}$ | $3x10^{-4}$ | D | None | OSHA-PEL: 0.05 $mg/m^3$[g]<br>NIOSH-REL: 0.05 $mg/m^3$ [8 hr TWA] [skin][d] |
| Methane | 74-82-8 | NA | NA | NA | NA | Simple asphyxiant[h] |
| Methanol | 67-56-1 | $5x10^{-1}$ | 1.75[c] | NA | None | OSHA-PEL: 260 $mg/m^3$, 325 $mg/m^3$ [STEL] [skin][g]<br>ACGIH-TLV: 200 ppm, 250 ppm [STEL] [skin][g]<br>NIOSH-REL: 260 $mg/m^3$ [skin], 325 $mg/m^3$ [ceiling] [skin][f] |
| Methyl bromide | 74-83-9 | 0.133 | 0.465 | NA | None | OSHA-PEL: 80 $mg/m^3$[g]<br>ACGIH-TLV: 19 $mg/m^3$ (SKIN)[e]<br>NIOSH-REL: Reduce to lowest level, the IDLH is 7900 $mg/m^3$ |
| Methylene chloride | 75-09-2 | $6x10^{-2}$ | 3* | $B_2$ | $7.5x10^{-3}$ (oral) | OSHA-PEL: 1,765 $mg/m^3$ [8-hr TWA], 3500 $mg/m^3$ [ceiling][d]<br>ACGIH-TLV: 174 $mg/m^3$[e]<br>NIOSH-REL: reduce exposure to lowest feasible concentration[d] |
| Methyl ethyl ketone (2-butanone) | 78-93-3 | $5x10^{-2}$* (withdrawn) | $1x10^{0}$ [0.6*] | D | None | OSHA-PEL: 590 $mg/m^3$ [8-hr TWA], 885 $mg/m^3$ [15-min ST limit][d]<br>ACGIH-TLV: same as above[d]<br>NIOSH-REL: same as above[i] |
| Methyl isobutyl ketone | 108-10-1 | $8x10^{-2}$* (alternate method) | $5x10^{-2}$* [0.08*] | NA | None | OSHA-PEL: 205 $mg/m^3$, 300 $mg/m^3$ [STEL][d]<br>ACGIH-TLV: 205 $mg/m^3$, 300 $mg/m^3$ [STEL][e]<br>NIOSH-REL: 205 $mg/m^3$, 300 $mg/m^3$ [STEL][f] |
| Methyl-tert-butyl ether | 1634-04-4 | .005 | 0.5 | NA | None | OSHA-PEL: [i]<br>ACGIH-TLV:[i]<br>NIOSH-REL:[i] |
| Naphtha | 8030-30-6 | 8.4[b] | 29.4[c] | NA | None | OSHA-PEL: 400 $mg/m^3$[d]<br>ACGIH-TLV: 1,200 $mg/m^3$[h]<br>NIOSH-REL: 400 $mg/m^3$[d] |
| Naphthalene | 91-21-3 | $4x10^{-3}$ | .0139 | D | None | OSHA-PEL: 50 $mg/m^3$[d]<br>ACGIH-TLV: 52 $mg/m^3$[e]<br>NIOSH-REL: 50 $mg/m^3$[d] |
| Nickel | 7440-02-0 | $2x10^{-2}$ | $2x10^{-2}$ | A | 0.84 | OSHA-PEL: 0.1 $mg/m^3$[d]<br>ACGIH-TLV: 1 $mg/m^3$[e]<br>NIOSH-REL: .015 $mg/m^3$[d] |

**TABLE E.3–2.—*Table of Exposure Limits* [Page 7 of 9]**

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Nickel oxide | 7440-02-0 | $3x10^{-4}$ | $1.2x10^{-3}$ | NA | None | OSHA-PEL: 0.1 $mg/m^3$[d]<br>ACGIH-TLV: 0.1 $mg/m^3$[e] |
| Nitric acid | 7697-37-2 | 0.035[b] | 0.123 (PNL) | NA | None | OSHA-PEL: 5 $mg/m^3$ and a 15 minute STEL 10 $mg/m^3$[d]<br>NIOSH-REL: same as above[d] |
| Nitrocellulose (cellulose tetranitrate) | 9004-70-0 | $2.0x10^{-1}$ [m] | $7.0x10^{-1}$ [c] | e | None | OSHA-PEL: NA<br>ACGIH-TLV: NA<br>RTECS-TWA: >5g/kg (oral rat/mouse) |
| Perfluoroalkylether (isoflurane) | 26675-46-7 | 5.07[h] | 17.76[c] | e | None | OSHA-PEL: NA<br>ACGIH-TLV: NA<br>Sax/Japan TWA: Inhal. Rat - 116,647 $mg/m^3$ |
| Perfluoro compounds (e.g., tetra CFCs) | 76-14-2 | 49[j] | 171.3 | e | None | OSHA-PEL: 7,000 $mg/m^3$<br>ACGIH-TLV: 6,990 $mg/m^3$<br>NIOSH-REL: 7,000 $mg/m^3$ |
| Phenol | 108-95-2 | 0.6 | 2.098 | D[g] | None | OSHA-PEL: 19 $mg/m^3$[d]<br>ACGIH-TLV: 19 $mg/m^3$[e]<br>NIOSH-REL: 19 $mg/m^3$[d] |
| Phosphoric acid | 7664-38-2 | $7x10^{-3}$ | $2.44x10^{-3}$ | NA | None | OSHA-PEL: 1 $mg/m^3$[d]<br>ACGIH-TLV: 1 $mg/m^3$[e]<br>NIOSH-REL: 1 $mg/m^3$[d] and an IDLH of 10,000 $mg/m^3$[d] |
| Propane | 74-98-6 | 12.6[l] | 44.1[c] | NA | None | OSHA-PEL: 1,800 $mg/m^3$<br>ACGIH-TLV: 1,800 $mg/m^3$<br>NIOSH-REL: 1,800 $mg/m^3$ |
| Propylene dichloride | 78-87-5 | 2.429[b] | 8.494[c] | $B_2$ | 0.068 | OSHA-PEL: 350 $mg/m^3$ and a STEL of 510 $mg/m^3$[d]<br>ACGIH-TLV: 347 $mg/m^3$[e]<br>NIOSH-IDLH: 9,400 $mg/m^3$[d] |
| Propyl glycol methyl ether (propylene glycol monomethyl ether) | 107-98-2 | 2.583[b] | 9.04[c] | NA | None | OSHA-PEL: NA<br>ACGIH-TLV: 369 $mg/m^3$<br>OSHA-TWA: 360 $mg/m^3$ |
| Resins and formers (toluene-2,4-diisocyanate) | 584-84-9 | $2.8x10^{-4}$ [j,b] | $9.8x10^{-4}$ [p,b] | NA | None | OSHA-PEL: 0.14 $mg/m^3$<br>ACGIH-TLV: 0.036 $mg/m^3$<br>NIOSH-REL: 0.04 $mg/m^3$ |
| Sodium hydroxide | 1310-73-2 | $1.4x10^{-2}$ | $4.89x10^{-2}$ | NA | None | OSHA-PEL: 2 $mg/m^3$[d]<br>ACGIH-TLV: 2 $mg/m^3$[e]<br>NIOSH-REL: 2 $mg/m^3$[d] |
| Sodium hypochlorite | 7681-52-9 | [i] | [i] | [i] | None | OSHA-PEL: [i]<br>ACGIH-TLV: [i]<br>NIOSH-REL: [i] |

**TABLE E.3–2.—*Table of Exposure Limits* [Page 8 of 9]**

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Sulfuric acid | 7664-93-9 | 0.007[b] | 0.0245[c] | NA | None | OSHA-PEL: 1 $mg/m^3$[g]<br>ACGIH-TLV: same as above[h]<br>NIOSH-REL: same as above[f] |
| Tetrachloroethane (1,1,2,2) | 79-34-5 | 0.483[b] | 0.169[c] | C[k] | 0.26* | OSHA-PEL: 35 $mg/m^3$[d]<br>ACGIH-TLV: 6.9 $mg/m^3$[e]<br>NIOSH-REL: 7 $mg/m^3$[d], the IDLH is 1,050 $mg/m^3$[d] |
| Tetrahydrofuran | 109-99-9 | 4.13[b] | 14.455[c] | NA | None | OSHA-PEL: 590 $mg/m^3$<br>ACGIH-TLV: 590 $mg/m^3$<br>NIOSH-REL: 590 $mg/m^3$ |
| Toluene | 108-88-3 | 0.2 | 0.4 | D | None | OSHA-PEL: 375 $mg/m^3$, 560 $mg/m^3$ [ST][d]<br>ACGIH-TLV: 377 $mg/m^3$, 565 $mg/m^3$ [STEL][e]<br>NIOSH-REL: 375 $mg/m^3$, 560 $mg/m^3$ [STEL][f] |
| Trichloroethane (1,1,1) | 71-55-6 | $3.5 \times 10^{-2}$# | 1.0* | D | None | ACGIH-TLV: 1,900 $mg/m^3$[f]<br>NIOSH-REL: 1,910 $mg/m^3$[d] |
| Trichloroethane (1,1,2) | 79-00-5 | $4 \times 10^{-2}$* | under review $1.4 \times 10^{-2}$ | C | $5.7 \times 10^{-2}$ (inhal)* | OSHA-PEL: 45 $mg/m^3$ (skin)[d]<br>ACGIH-TLV: 55 $mg/m^3$[e]<br>NIOSH-REL: 45 $mg/m^3$ (skin)[d] |
| Trichloroethylene | 79-01-6 | $7.35 \times 10^{-3}$# | 0.046 (PNL) | $B_2$ | $6.0 \times 10^{-3}$ (inhal) $1.1 \times 10^{-2}$ (oral) | OSHA-PEL: 270 $mg/m^3$ STEL 1080 $mg/m^3$[d]<br>ACGIH-TLV: 270 $mg/m^3$ and STEL of 1,070 $mg/m^3$[e]<br>NIOSH-REL: 1,370 $mg/m^3$[h] |
| Uranium (235, 238) | 7440-61-1 | 0.003 | 0.0105[c] | A | $2.4 \times 10^{-8}$/pCi (inhal) | OSHA-PEL: soluble cmpds-.05 $mg/m^3$, insoluble cmpds-0.2 $mg/m^3$[d]<br>ACGIH-TLV: .2 $mg/m^3$[e]<br>NIOSH-REL: soluble .2 $mg/m^3$, insoluble .05 $mg/m^3$[d] |
| Vinyl acetate | 108-05-4 | 1[i] | 0.2[g] | D | None | OSHA-PEL: 30 $mg/m^3$, STEL 60 $mg/m^3$[f]<br>ACGIH-TLV: 35 $mg/m^3$, STEL 70 $mg/m^3$[e]<br>NIOSH-REL: 15 $mg/m^3$[f] |
| Vinyl chloride | 75-01-4 | None | None | A | 0.3 (inhal) | OSHA-PEL: 2.6 $mg/m^3$[d]<br>ACGIH-TLV: 13 $mg/m^3$[e] |

**TABLE E.3–2.—*Table of Exposure Limits* [Page 9 of 9]**

| Compound | Chemical Abstracts Service No. | Reference[a] Dose (oral) (mg/kg/day) | Reference[a] Concentration (inhalation) ($mg/m^3$) | Cancer Class[a] | Slope Factor[a] $(mg/kg/day)^{-1}$ | Occupational Exposure Levels |
|---|---|---|---|---|---|---|
| Xylene | 1330-20-7 | 2[b] [2*] | 7[c] | D | None | OSHA-PEL: 435 $mg/m^3$, 655 $mg/m^3$ [STEL][g]<br>ACGIH-TLV: same as above[h]<br>NIOSH-REL: same as above[f] |

[a] The majority of the Reference Dose and Reference Concentration values in this table were taken from the Integrated Risk Information System (EPA 1993c) for the particular chemical. In a few cases, values were copied from the Health Effects Assessment Summary Tables. Values from the HEAST tables are denoted with the symbol (*) (EPA 1993a). Values followed by the symbol (#) were taken from the Office of Drinking Water's Health Advisories. Values from Pacific Northwest Laboratories of Battelle 1991 are denoted as (PNL). The Cancer Class and Slope Factor are, likewise, from the Integrated Risk Information System unless indicated otherwise (EPA 1993c).

[b] Reference Dose calculated from the ACGIH-TLV, formula from the Center for Risk Management, Oak Ridge National Lab (EPA 1992d).

[c] Reference Concentration calculated from the Reference Dose, using formula from the Center for Risk Management, Oak Ridge National Lab (EPA 1992d).

[d] NIOSH 1990a.

[e] ACGIH 1992a.

[f] DHHS 1992b.

[g] 29 CFR 1910.

[h] Lewis 1992a.

[i] Information is not available.

[j] Reference Dose calculated from the value for the Reference Concentration.

[k] ORNL 1993b.

[l] Reference Dose calculated from the OSHA PEL/TWA.

[m] Reference Dose calculated from the RTECS LD50.

[o] Reference Dose calculated from the RTECS TWA/PEL.

[p] Reference Concentration calculated from the NIOSH PEL.

Note: NA - not applicable.

TABLE E.3.4–1.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Idaho National Engineering Laboratory*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acetone | 10.500 | 1,800 | 1,800 | 0 | $8.6x10^{-8}$ | $9.3x10^{-4}$ | $8.2x10^{-9}$ | $5.1x10^{-7}$ | 0 | 0 |
| Ammonia | 0.100 | 27 | 17 | 0 | $1.1x10^{-5}$ | 0.12 | $1.1x10^{-4}$ | $4.3x10^{-3}$ | 0 | 0 |
| Nitric Acid | 0.123 | 5 | 5 | 0 | $7.9x10^{-6}$ | 0.09 | $6.4x10^{-5}$ | 0.017 | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1,900 | 1,900 | 0 | $3.6x10^{-6}$ | 0.04 | $3.6x10^{-6}$ | $2.0x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $1.7x10^{-4}$ | 0.021 | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5.

**TABLE E.3.4.–2.—*Risk Assessments from Exposure to Hazardous Chemicals from Heavy Water Reactor Operation at Idaho National Engineering Laboratory***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.280 | 2,708 | 2,708 | None | $2.3x10^{-6}$ | 0.025 | $3.4x10^{-8}$ | $9.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.100 | 1,900 | 1,880 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $1.8x10^{-8}$ | $4.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $2.3x10^{-6}$ | 0.03 | 0 | 0 | 0 | 0 |
| Methanol | 1.750 | 260 | 200 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $4.8x10^{-7}$ | $3.5x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $4.3x10^{-6}$ | 0.046 | $3.5x10^{-5}$ | $9.3x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1,900 | 1,900 | None | $7.1x10^{-7}$ | $7.7x10^{-3}$ | $7.1x10^{-7}$ | $4.1x10^{-6}$ | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.000 | 7,600 | 7,600 | None | $3.0x10^{-5}$ | 0.33 | $2.9x10^{-7}$ | $4.3x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.6x10^{-5}$ | $9.4x10^{-3}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit .
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5.

**TABLE E.3.4.–3.—*Risk Assessments from Exposure to Hazardous Chemicals from Modular High Temperature Gas-Cooled Reactor Operation at Idaho National Engineering Laboratory***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $2.3x10^{-6}$ | 0.03 | $3.4x10^{-8}$ | $9.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $1.8x10^{-8}$ | $4.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $2.3x10^{-6}$ | 0.03 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $4.8x10^{-7}$ | $3.5x10^{-5}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.00 | 1,900 | 1,900 | None | $2.3x10^{-7}$ | 0.03 | $2.3x10^{-7}$ | $1.3x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $7.7x10^{-7}$ | $6.2x10^{-5}$ | 0 | |
| **Total Cancer Risk[g]** | | | | | | | 0 | 0 | 0 | 0 |

[a] MEI: maximally exposed individual of the public.

[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.

[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.

[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

[f] Hazard Index: sum of individual Hazard Quotients.

[g] Total Cancer Risk: sum of individual cancer risks.

Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5.

**TABLE E.3.4.–4.—*Risk Assessments from Exposure to Hazardous Chemicals from Advanced Light Water Reactor Operation at Idaho National Engineering Laboratory***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetone | 10.500 | 1,800 | 1,800 | None | $7.1x10^{-6}$ | 0.08 | $6.8x10^{-7}$ | $4.3x10^{-5}$ | 0 | 0 |
| Acetylene | 66.280 | 2,708 | 2,708 | None | $2.3x10^{-6}$ | 0.03 | $3.4x10^{-8}$ | $9.0x10^{-6}$ | 0 | 0 |
| Ammonia | 0.100 | 27 | 17 | None | $3.7x10^{-6}$ | 0.04 | $3.7x10^{-5}$ | $1.5x10^{-3}$ | 0 | 0 |
| Ethanol | 46.100 | 1,900 | 1,880 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $1.8x10^{-8}$ | $4.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $2.3x10^{-6}$ | 0.03 | 0 | 0 | 0 | 0 |
| Methanol | 1.750 | 260 | 200 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $4.8x10^{-7}$ | $3.5x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $5.0x10^{-5}$ | 0.54 | $4.1x10^{-4}$ | 0.11 | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1,900 | 1,900 | None | $1.6x10^{-5}$ | 0.18 | $1.6x10^{-5}$ | $9.3x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $4.6x10^{-4}$ | 0.11 | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.

[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.

[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.

[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

[f] Hazard Index: sum of individual Hazard Quotients.

[g] Total Cancer Risk: sum of individual cancer risks.

Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5; FDI Nov. 4, 1994, Log FO-94-0354.

TABLE E.3.4.–5.—*Risk Assessments from Exposure to Hazardous Chemicals from Accelerator Production of Tritium Operation at Idaho National Engineering Laboratory*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concen-tration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $2.3x10^{-6}$ | 0.03 | $3.4x10^{-8}$ | $9.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $1.8x10^{-8}$ | $4.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $2.3x10^{-6}$ | 0.03 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $4.8x10^{-7}$ | $3.5x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $5.4x10^{-7}$ | $4.9x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5.

**TABLE E.3.4.–6.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Operation at Idaho National Engineering Laboratory***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $2.3x10^{-6}$ | 0.03 | $3.4x10^{-8}$ | $9.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $1.8x10^{-8}$ | $4.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $2.3x10^{-6}$ | 0.03 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $8.5x10^{-7}$ | $9.2x10^{-3}$ | $4.8x10^{-7}$ | $3.5x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $5.4x10^{-7}$ | $4.9x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5.

**TABLE E.3.4.–7.—*Risk Assessments from Exposure to Hazardous Chemicals at Idaho National Engineering Laboratory—Summary Hazard Index and Total Cancer Risk***

| | Hazard Index | | Total Cancer Risk | |
|---|---|---|---|---|
| **Technology[a]** | **Boundary MEI[b,c] Annual** | **Worker 100 Meters 8 Hours[b]** | **Boundary MEI[d,e] Annual** | **Worker 100 Meters 8 Hours[d,f]** |
| No Action | $1.7 \times 10^{-4}$ | 0.021 | 0 | 0 |
| Tritium Recycle | $5.4 \times 10^{-7}$ | $4.9 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor | $3.6 \times 10^{-5}$ | $9.4 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor and Tritum Recycling | $3.7 \times 10^{-5}$ | $9.4 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor, Tritum Recycling, and No Action | $2.1 \times 10^{-4}$ | 0.031 | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor | $7.7 \times 10^{-7}$ | $6.2 \times 10^{-5}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor and Tritium Recycling | $1.3 \times 10^{-6}$ | $1.1 \times 10^{-4}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor, Tritium Recycling, and No Action | $1.8 \times 10^{-4}$ | 0.021 | 0 | 0 |
| Advanced Light Water Reactor | $4.6 \times 10^{-4}$ | 0.11 | 0 | 0 |
| Advanced Light Water Reactor and Tritium Recycling | $4.6 \times 10^{-4}$ | 0.11 | 0 | 0 |
| Advanced Light Water Reactor, Tritium Recycling, and No Action | $6.3 \times 10^{-4}$ | 0.13 | 0 | 0 |
| Accelerator Production of Tritium | $5.4 \times 10^{-7}$ | $4.9 \times 10^{-5}$ | 0 | 0 |
| Accelerator Production of Tritium and Tritium Recycling | $5.4 \times 10^{-6}$ | $9.8 \times 10^{-5}$ | 0 | 0 |
| Accelerator Production of Tritium, Tritium Recycling, and No Action | $1.8 \times 10^{-4}$ | 0.021 | 0 | 0 |

[a] Combined Hazard Index and total cancer risk for these alternatives.

[b] MEI: maximally exposed individual of the public.

[c] Hazard Index: sum of individual Hazard Quotients.

[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Total Cancer Risk: sum of individual cancer risks.

[f] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (slope factor).

Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; INEL 1993a:5.

TABLE E.3.4–8.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Nevada Test Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| None | None | None | None | None | None | None | None | None | None | None |
| **Hazard Index[f]** | | | | | | | None | None | None | None |
| **Total Cancer Risk[g]** | | | | | | | None | None | None | None |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4.

TABLE E.3.4–9.—*Risk Assessments from Exposure to Hazardous Chemicals from Heavy Water Reactor Operation at Nevada Test Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.280 | 2,708 | 2,708 | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | $5.8x10^{-9}$ | $3.1x10^{-6}$ | 0 | 0 |
| Ethanol | 46.100 | 1,900 | 1,880 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $3.1x10^{-9}$ | $1.7x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.750 | 260 | 200 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $8.2x10^{-8}$ | $1.2x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $7.3x10^{-7}$ | 0.016 | $5.9x10^{-6}$ | $3.2x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1,900 | 1,910 | None | $1.2x10^{-7}$ | $2.7x10^{-3}$ | $1.2x10^{-7}$ | $1.4x10^{-6}$ | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.000 | 7,600 | 7,670 | None | $5.2x10^{-6}$ | 0.11 | $4.9x10^{-8}$ | $1.5x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $6.2x10^{-6}$ | $3.2x10^{-3}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4.

**TABLE E.3.4–10.**—*Risk Assessments from Exposure to Hazardous Chemicals Modular High Temperature Gas-Cooled Reactor Operation at Nevada Test Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | $5.8x10^{-9}$ | $3.1x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $3.1x10^{-9}$ | $1.7x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $8.2x10^{-8}$ | $1.2x10^{-5}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.00 | 1,900 | 1,910 | None | $3.9x10^{-8}$ | $8.6x10^{-4}$ | $3.9x10^{-8}$ | $4.5x10^{-7}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $1.3x10^{-7}$ | $1.7x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4.

**TABLE E.3.4–11.—*Risk Assessments from Exposure to Hazardous Chemicals from Advanced Light Water Reactor Operation at Nevada Test Site***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetone | 10.500 | 1,800 | 1,800 | None | $1.2x10^{-6}$ | 0.03 | $1.2x10^{-7}$ | $1.5x10^{-5}$ | 0 | 0 |
| Acetylene | 66.280 | 2,708 | 2,708 | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | $5.8x10^{-9}$ | $3.1x10^{-6}$ | 0 | 0 |
| Ammonia | 0.100 | 27 | 17 | None | $6.4x10^{-7}$ | 0.014 | $6.4x10^{-6}$ | $5.1x10^{-4}$ | 0 | 0 |
| Ethanol | 46.100 | 1,900 | 1,880 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $3.1x10^{-9}$ | $1.7x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.750 | 260 | 200 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $8.2x10^{-8}$ | $1.2x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $8.5x10^{-6}$ | 0.19 | $6.9x10^{-5}$ | 0.037 | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1,900 | 1,900 | None | $2.8x10^{-6}$ | $6.1x10^{-2}$ | $2.8x10^{-6}$ | $3.2x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $7.7x10^{-5}$ | $3.8x10^{-2}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4.

**TABLE E.3.4.–12.**—*Risk Assessments from Exposure to Hazardous Chemicals from Accelerator Production of Tritium Operation at Nevada Test Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | $5.8x10^{-9}$ | $3.1x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $3.1x10^{-9}$ | $1.7x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $8.2x10^{-8}$ | $1.2x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $9.1x10^{-8}$ | $1.7x10^{-5}$ | 0 | 0 |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4.

TABLE E.3.4–13.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Operation at Nevada Test Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | $5.8x10^{-9}$ | $3.1x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $3.1x10^{-9}$ | $1.7x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $3.9x10^{-7}$ | $8.4x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $1.4x10^{-7}$ | $3.2x10^{-3}$ | $8.2x10^{-8}$ | $1.2x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $9.1x10^{-8}$ | $1.7x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4.

**TABLE E.3.4–14.—*Risk Assessments from Exposure to Hazardous Chemicals at Nevada Test Site—Summary Hazard Index and Total Cancer Risk***

| Technology[a] | Hazard Index | | Total Cancer Risk | |
|---|---|---|---|---|
| | Boundary MEI[b,c] Annual | Worker 100 Meters 8 Hours[b] | Boundary MEI[d,e] Annual | Worker 100 Meters 8 Hours[d,f] |
| No Action | 0 | 0 | 0 | 0 |
| Tritium Recycle | $9.1 \times 10^{-8}$ | $1.7 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor | $6.2 \times 10^{-6}$ | $3.2 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor and Tritum Recycling | $6.3 \times 10^{-6}$ | $3.2 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor, Tritum Recycling, and No Action | $6.3 \times 10^{-6}$ | $3.2 \times 10^{-3}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor | $1.3 \times 10^{-7}$ | $1.7 \times 10^{-5}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor and Tritium Recycling | $2.2 \times 10^{-7}$ | $3.4 \times 10^{-5}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor, Tritium Recycling and No Action | $2.2 \times 10^{-7}$ | $3.4 \times 10^{-5}$ | 0 | 0 |
| Advanced Light Water Reactor | $7.7 \times 10^{-5}$ | 0.038 | 0 | 0 |
| Advanced Light Water Reactor and Tritium Recycling | $7.7 \times 10^{-5}$ | 0.038 | 0 | 0 |
| Advanced Light Water Reactor, Tritium Recycling, and No Action | $7.7 \times 10^{-5}$ | 0.038 | 0 | 0 |
| Accelerator Production of Tritium | $9.1 \times 10^{-8}$ | $1.7 \times 10^{-5}$ | 0 | 0 |
| Accelerator Production of Tritium and Tritium Recycling | $1.8 \times 10^{-7}$ | $3.4 \times 10^{-5}$ | 0 | 0 |
| Accelerator Production of Tritium, Tritium Recycling, and No Action | $1.8 \times 10^{-7}$ | $3.4 \times 10^{-5}$ | 0 | 0 |

[a] Combined Hazard Index and total cancer risk for these alternatives.
[b] MEI: maximally exposed individual of the public.
[c] Haxard Index: sum of individual Hazard Quotients.
[d] Cancer Risk for MEI: (emissions concentration)x(0.286[converts concentration to doses])x(slope factor).
[e] Total Cancer Risk: sum of individual cancer risks.
[f] Cancer Risk for Workers: (emissions for 8-hr)x(0.286[converts concentrations to doses])x(slope factor).
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; NTS 1993a:4; FDI Nov.4, 1994 Log #FO-94-0354.

**TABLE E.3.4–15.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Oak Ridge Reservation***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Chlorine | 0.004 | 1.5 | 1.5 | None | $3.0x10^{-4}$ | 0.06 | 0.08 | 0.04 | 0 | 0 |
| Chlorodifluoromethane (Freon 22) | 86.700 | 3,540.0 | 3,540.0 | None | $6.4x10^{-4}$ | 0.12 | $7.3x10^{-6}$ | $3.4x10^{-5}$ | 0 | 0 |
| Dichlorodifluoromethane (Freon 12) | 0.700 | 4,950.0 | 4,950.0 | None | $5.6x10^{-4}$ | 0.11 | $8.0x10^{-4}$ | $2.2x10^{-5}$ | 0 | 0 |
| Hydrogen chloride | 0.007 | 7.0 | 7.0 | None | $1.3x10^{-3}$ | 0.25 | 0.18 | 0.04 | 0 | 0 |
| Methanol | 1.750 | 260.0 | 200.0 | None | $4.8x10^{-3}$ | 0.92 | $2.7x10^{-3}$ | $3.6x10^{-3}$ | 0 | 0 |
| Nitric acid | 0.123 | 5.0 | 5.0 | None | $1.7x10^{-3}$ | 0.33 | 0.01 | 0.07 | 0 | 0 |
| Sulfuric acid | 0.025 | 1.0 | 1.0 | None | $4.5x10^{-4}$ | 0.09 | 0.02 | 0.09 | 0 | 0 |
| Tetrachloroethylene (PERC) | 0.035 | 170.0 | | None | $2.2x10^{-3}$ | 0.43 | 0.06 | $2.5x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1.0 | 1,900.0 | None | $1.4x10^{-4}$ | 0.03 | $1.4x10^{-4}$ | 0.03 | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.000 | 7,600.0 | 7,670.0 | None | $5.0x10^{-4}$ | 0.10 | $4.8x10^{-6}$ | $1.3x10^{-5}$ | 0 | 0 |
| Trichlorofluoromethane (Freon 11) | 1.050 | 5,620.0 | 5,620.0 | None | $1.5x10^{-3}$ | 0.28 | $1.4x10^{-3}$ | $5.0x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | 0.36 | 0.26 | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8.

**TABLE E.3.4–16.—*Risk Assessments from Exposure to Hazardous Chemicals from Heavy Water Reactor Operation at Oak Ridge Reservation***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-4}$ | 0.02 | $1.6x10^{-6}$ | $7.4x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $8.5x10^{-7}$ | $4.0x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-4}$ | 0.02 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $2.2x10^{-5}$ | $2.9x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.12 | 5 | 5 | None | $2.0x10^{-4}$ | 0.04 | $1.6x10^{-3}$ | $7.6x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.00 | 1,900 | 1,910 | None | $3.3x10^{-5}$ | $6.3x10^{-3}$ | $3.3x10^{-5}$ | $3.3x10^{-6}$ | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.00 | 7,600 | 7,670 | None | $1.4x10^{-3}$ | 0.27 | $1.3x10^{-5}$ | $3.5x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $1.7x10^{-3}$ | $7.7x10^{-3}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8.

**TABLE E.3.4–17.—*Risk Assessments from Exposure to Hazardous Chemicals from Modular High Temperature Gas-Cooled Reactor Operation at Oak Ridge Reservation***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-4}$ | 0.02 | $9.6x10^{-5}$ | 0.02 | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $4.8x10^{-5}$ | $9.1x10^{-3}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-4}$ | 0.02 | $9.6x10^{-5}$ | 0.02 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $4.8x10^{-5}$ | $9.1x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.00 | 1,900 | 1,910 | None | $1.1x10^{-5}$ | $2.1x10^{-3}$ | $1.1x10^{-5}$ | $2.1x10^{-3}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.0x10^{-4}$ | 0.057 | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8.

**TABLE E.3.4–18.—*Risk Assessments from Exposure to Hazardous Chemicals from Advanced Light Water Reactor Operation at Oak Ridge Reservation***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetone | 10.50 | 1,800 | 1,800 | None | $3.3x10^{-4}$ | 0.06 | $3.2x10^{-5}$ | $3.5x10^{-5}$ | 0 | 0 |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-4}$ | 0.02 | $1.6x10^{-6}$ | $7.4x10^{-6}$ | 0 | 0 |
| Ammonia | 0.10 | 27 | 17 | None | $1.7x10^{-4}$ | 0.03 | $1.7x10^{-3}$ | $1.2x10^{-3}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $8.5x10^{-7}$ | $4.0x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-4}$ | 0.02 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $2.2x10^{-5}$ | $2.9x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.12 | 5 | 5 | None | $2.3x10^{-3}$ | 0.44 | 0.019 | 0.09 | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.000 | 1,900 | 1,900 | None | $7.6x10^{-4}$ | 0.015 | $7.6x10^{-4}$ | $7.7x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | 0.02 | 0.09 | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8; FDI Nov. 4, 1994 Log # FO-94-0354.

**TABLE E.3.4–19.—*Risk Assessments from Exposure to Hazardous Chemicals from Accelerator Production of Tritium Operation at Oak Ridge Reservation***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-4}$ | 0.02 | $1.6x10^{-6}$ | $7.4x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $8.5x10^{-7}$ | $4.0x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-4}$ | 0.02 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $2.2x10^{-5}$ | $2.9x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $2.5x10^{-5}$ | $4.0x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8.

**TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Operation at Oak Ridge Reservation***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-4}$ | 0.02 | $1.6x10^{-6}$ | $7.4x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $8.5x10^{-7}$ | $4.0x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-4}$ | 0.02 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $3.9x10^{-5}$ | $7.5x10^{-3}$ | $2.2x10^{-5}$ | $2.9x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $2.5x10^{-5}$ | $4.0x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emmissions/reference concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/permissible exposure limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual Hazard Quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8.

TABLE E.3.4–21.—*Risk Assessments from Exposure to Hazardous Chemicals at Oak Ridge Reservation–Summary Hazard Index and Total Cancer Risk*

| Technology[a] | Hazard Index | | Total Cancer Risk | |
|---|---|---|---|---|
| | Boundary MEI[b, c] Annual | Worker 100 Meters 8 Hours[b] | Boundary MEI[d, e] Annual | Worker 100 Meters 8 Hours[d, f] |
| No Action | 0.36 | 0.26 | 0 | 0 |
| Tritium Recycle | $2.5 \times 10^{-5}$ | $4.0 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor | $1.7 \times 10^{-3}$ | $7.7 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor and Tritium Recycling | $1.7 \times 10^{-3}$ | $7.7 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor, Tritium Recycling and No Action | 0.36 | 0.27 | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor | $3.0 \times 10^{-4}$ | 0.06 | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor and Tritium Recycling | $3.2 \times 10^{-4}$ | 0.06 | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor, Tritium Recycling and No Action | 0.36 | 0.32 | 0 | 0 |
| Advanced Light Water Reactor | 0.022 | 0.090 | 0 | 0 |
| Advanced Light Water Reactor and Tritium Recycling | 0.022 | 0.090 | 0 | 0 |
| Advanced Light Water Reactor, Tritium Recycling and No Action | 0.38 | 0.35 | 0 | 0 |
| Accelerated Production of Tritium | $2.5 \times 10^{-5}$ | $4.0 \times 10^{-5}$ | 0 | 0 |
| Accelerated Production of Tritium and Tritium Recycling | $5.0 \times 10^{-5}$ | $8.1 \times 10^{-5}$ | 0 | 0 |
| Accelerated Production of Tritium, Tritium Recycling and No Action | 0.36 | 0.26 | 0 | 0 |

[a] Combined Hazard Index and total cancer risk for these alternatives.
[b] MEI: maximally exposed individual of the public.
[c] Hazard Index: sum of individual Hazard Quotient.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Total Cancer Risk: sum of individual cancer risks.
[f] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (slope factor).
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; ORR 1993a:8; FDI Nov. 4, 1994 Log #FO-94-0354

TABLE E.3.4–22.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Pantex Plant* [Page 1 of 3]

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acetone | 10.50 | 1,800.0 | 1,800.0 | None | $2.0x10^{-4}$ | 0.39 | $1.9x10^{-5}$ | $2.2x10^{-4}$ | 0 | 0 |
| Aldehydes (formaldehyde) | 0.70 | 1.249 | 0.37 | 0.0450 | $2.5x10^{-8}$ | $2.8x10^{-3}$ | $3.5x10^{-8}$ | $2.2x10^{-3}$ | $3.2x10^{-10}$ | $4.8x10^{-6}$ |
| Aliphatic alcohols (n-butyl alcohol) | 0.35 | 150.0 | | None | $7.6x10^{-8}$ | $5.5x10^{-4}$ | $2.2x10^{-7}$ | $3.7x10^{-6}$ | 0 | 0 |
| Aliphatic hydrocarbons (cyclohexane) | 25.70 | 1,050.0 | 1,050.0 | None | $3.2x10^{-6}$ | 0.02 | $1.2x10^{-7}$ | $2.0x10^{-5}$ | 0 | 0 |
| Aromatic hydrocarbons (pyrene) | 0.105 | 0.2 | 10.5 | 5.7900 | $4.5x10^{-6}$ | 0.03 | $4.3x10^{-5}$ | 0.15 | $7.4x10^{-6}$ | $6.9x10^{-3}$ |
| Aromatic petroleum distillates (benzo (a) pyrene) | 105.00 | 0.2 | | 5.7900 | $2.4x10^{-6}$ | 0.02 | $2.2x10^{-8}$ | 0.08 | $3.9x10^{-6}$ | $3.5x10^{-3}$ |
| 2-butoxyethanol | 2.96 | 240.0 | | None | $1.3x10^{-4}$ | 0.24 | $4.4x10^{-5}$ | $9.9x10^{-4}$ | 0 | 0 |
| Butyl acetate | 17.40 | 710.0 | 710.0 | None | $1.4x10^{-5}$ | 0.10 | $8.0x10^{-7}$ | $1.4x10^{-4}$ | 0 | 0 |
| Butyl alcohol | 0.35 | 150.0 | 152.0 | None | $5.2x10^{-6}$ | 0.04 | $1.5x10^{-5}$ | $2.4x10^{-4}$ | 0 | 0 |
| Chlorodifluoromethane (Freon 142) | 86.70 | 3,540.0 | | None | $3.0x10^{-6}$ | $5.5x10^{-3}$ | $3.5x10^{-8}$ | $1.6x10^{-6}$ | 0 | 0 |
| Cyanogen | 0.245 | 20.0 | | None | $7.6x10^{-6}$ | 0.18 | $3.1x10^{-5}$ | $9.2x10^{-3}$ | 0 | 0 |
| Cyclohexane | 25.70 | 1,050.0 | 1,050.0 | None | $1.8x10^{-6}$ | $3.3x10^{-3}$ | $7.1x10^{-8}$ | $3.2x10^{-6}$ | 0 | 0 |
| Diacetone alcohol | 5.88 | 240.0 | | None | $1.5x10^{-7}$ | $1.1x10^{-3}$ | $2.6x10^{-8}$ | $4.6x10^{-6}$ | 0 | 0 |
| Dibutyl phthalate | 0.35 | 5.0 | 5.0 | None | $2.3x10^{-7}$ | $1.7x10^{-3}$ | 0 | 0 | 0 | 0 |
| Dichlorodifluromethane (Freon 12) | 0.70 | 4,950.0 | 4,950.0 | None | $4.3x10^{-6}$ | 0.03 | $6.2x10^{-6}$ | $5.4x10^{-6}$ | 0 | 0 |
| Diesel (undefined complex) | | | | None | $1.5x10^{-6}$ | $2.8x10^{-3}$ | 0 | 0 | 0 | 0 |
| Diethylene glycol ethyl ether | 0.35 | 50.0 | | None | $7.6x10^{-8}$ | $5.5x10^{-4}$ | $2.2x10^{-7}$ | 0 | 0 | 0 |
| Epoxy solvent (toluene) | 0.40 | 375.0 | | None | $2.6x10^{-6}$ | 0.02 | $6.5x10^{-6}$ | $5.0x10^{-5}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900.0 | 1,880.0 | None | $3.5x10^{-6}$ | 0.01 | $7.6x10^{-8}$ | $7.3x10^{-6}$ | 0 | 0 |
| Ethyl acetate | 3.15 | 1,400.0 | 1,400.0 | None | $9.9x10^{-7}$ | $7.2x10^{-3}$ | $3.1x10^{-7}$ | $5.1x10^{-6}$ | 0 | 0 |

TABLE E.3.4–22.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Pantex Plant* [Page 2 of 3]

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Ethyl benzene | 1.00 | 435.0 | | None | $1.5x10^{-7}$ | $1.1x10^{-3}$ | $1.5x10^{-7}$ | $2.5x10^{-6}$ | 0 | 0 |
| Freon TF (Freon 11) | 1.05 | 5,600.0 | 5,620.0 | None | $1.6x10^{-5}$ | 0.03 | $1.5x10^{-5}$ | $5.0x10^{-6}$ | 0 | 0 |
| Heptane | 40.1 | 2,000.0 | 1,640.0 | None | $3.8x10^{-7}$ | $2.8x10^{-3}$ | $9.5x10^{-9}$ | $1.4x10^{-6}$ | 0 | 0 |
| Hydrocarbons (heptane) | 40.1 | 2,000.0 | | None | $8.0x10^{-5}$ | 2.06 | 0 | 0 | 0 | 0 |
| Hydrogen chloride | 0.007 | 7.0 | 7.0 | None | $1.1x10^{-5}$ | 0.26 | $1.6x10^{-3}$ | 0.04 | 0 | 0 |
| Hydrogen cyanide | 0.07 | 5.0 | | None | $1.1x10^{-6}$ | 0.03 | $1.5x10^{-5}$ | $5.1x10^{-3}$ | 0 | 0 |
| Hydrogen flouride | 0.063 | 2.5 | 2.6 | None | $1.3x10^{-5}$ | 0.33 | $2.1x10^{-4}$ | 0.13 | 0 | 0 |
| Isopropyl alcohol | 24.15 | 980.0 | 980.0 | None | $2.2x10^{-5}$ | 0.14 | $8.9x10^{-7}$ | $1.5x10^{-4}$ | 0 | 0 |
| Isobutane | 35.04 | 1,430.0 | | None | $2.3x10^{-7}$ | $1.7x10^{-3}$ | $6.5x10^{-9}$ | 0 | 0 | 0 |
| Isobutyl acetate | 17.15 | 700.0 | | None | $3.8x10^{-7}$ | $2.8x10^{-3}$ | $2.2x10^{-8}$ | $3.9x10^{-6}$ | 0 | 0 |
| Methanol | 1.75 | 260.0 | 200.0 | None | $1.1x10^{-4}$ | 0.20 | $6.3x10^{-5}$ | $7.8x10^{-4}$ | 0 | 0 |
| Methyl ethyl ketone | 1.00 | 590.0 | 590.0 | None | $1.5x10^{-5}$ | 0.11 | $1.5x10^{-5}$ | $1.8x10^{-4}$ | 0 | 0 |
| Methyl isobutyl ketone | 0.05 | 205.0 | 205.0 | None | $1.7x10^{-6}$ | $6.1x10^{-3}$ | $3.5x10^{-5}$ | $3.0x10^{-5}$ | 0 | 0 |
| Methylene chloride | 3.00 | 1,765.0 | | 0.0075 | $7.6x10^{-7}$ | $2.2x10^{-3}$ | $2.5x10^{-7}$ | $1.2x10^{-6}$ | $1.6x10^{-9}$ | $6.4x10^{-7}$ |
| Nitrocellulose | 0.70 | 100.0 | | None | $5.3x10^{-7}$ | $3.9x10^{-3}$ | $7.6x10^{-7}$ | $3.9x10^{-5}$ | 0 | 0 |
| Perfluoroalkylether (isoflurane) | 17.76 | 2,537.143 | | None | $7.6x10^{-8}$ | $5.5x10^{-4}$ | $4.3x10^{-9}$ | $2.2x10^{-7}$ | 0 | 0 |
| Perfluoro compounds (Freon 114) | 171.30 | 7,000.0 | | None | $3.0x10^{-7}$ | $5.5x10^{-4}$ | $1.8x10^{-9}$ | $7.9x10^{-8}$ | 0 | 0 |
| Propane | 44.10 | 1,800.0 | | None | $6.8x10^{-7}$ | $5.0x10^{-3}$ | $1.5x10^{-8}$ | $2.8x10^{-6}$ | 0 | 0 |
| Propyl glycol methyl ether (propylene glycol monomethyl ether) | 9.04 | 369.0 | | None | $3.0x10^{-7}$ | $2.2x10^{-3}$ | $3.4x10^{-8}$ | $6.0x10^{-6}$ | 0 | 0 |
| Resins and formers (toluene-2,4 diisocyanate) | 0.001 | 0.14 | | None | $1.3x10^{-6}$ | $9.4x10^{-3}$ | $1.3x10^{-3}$ | 0.07 | 0 | 0 |
| Methyl tert butyl ether | 0.5 | 71.429 | | None | $5.1x10^{-6}$ | $2.2x10^{-3}$ | 0 | 0 | 0 | 0 |
| Tetrahydrofuran | 14.46 | 590.0 | | None | $1.9x10^{-5}$ | 0.03 | $1.3x10^{-6}$ | $5.7x10^{-5}$ | 0 | 0 |

**TABLE E.3.4–22.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Pantex Plant* [Page 3 of 3]**

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Toluene | 0.4 | 375.0 | 383.0 | None | $1.3x10^{-4}$ | 0.27 | $3.2x10^{-4}$ | $7.1x10^{-4}$ | 0 | 0 |
| 1,1,1 Trichloroethane (TCA) | 1.0 | 1,900.0 | 1,900.0 | None | $2.2x10^{-6}$ | $9.4x10^{-3}$ | $2.2x10^{-6}$ | $4.9x10^{-6}$ | 0 | 0 |
| Trichloroethylene | 0.046 | 270.0 | | 0.006 | $7.9x10^{-8}$ | $5.5x10^{-4}$ | $1.7x10^{-6}$ | $2.0x10^{-6}$ | $1.3x10^{-10}$ | $1.3x10^{-7}$ |
| Trichlorofluoromethane (Freon 11) | 1.05 | 5,600.0 | 5,620.0 | None | $4.6x10^{-7}$ | $1.7x10^{-3}$ | $4.3x10^{-7}$ | $2.9x10^{-7}$ | 0 | 0 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113) | 105.0 | 7,600.0 | 7,600.0 | None | $3.3x10^{-6}$ | 0.01 | $3.2x10^{-8}$ | $1.9x10^{-6}$ | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.0 | 7,600.0 | 7,600.0 | None | $4.1x10^{-6}$ | $8.3x10^{-3}$ | $3.9x10^{-8}$ | $1.1x10^{-6}$ | 0 | 0 |
| VM and P naptha | 29.4 | 400.0 | | None | $3.9x10^{-6}$ | 0.03 | 0.03 | 0 | 0 | 0 |
| Xylene | 7.0 | 435.0 | | None | $2.7x10^{-6}$ | 0.05 | | | | |
| **Hazard Index[f]** | | | | | | | 0.03 | 0.49 | | |
| **Total Cancer Risk[g]** | | | | | | | | | $1.1x10^{-5}$ | $1.0x10^{-2}$ |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; PX 1992a:10.

**TABLE E.3.4–23.—*Risk Assessments from Exposure to Hazardous Chemicals from Heavy Water Reactor Operation at Pantex Plant***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.9x10^{-3}$ | $8.1x10^{-3}$ | $2.8x10^{-5}$ | $3.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $1.5x10^{-7}$ | $1.6x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.9x10^{-3}$ | $8.1x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $4.0x10^{-6}$ | $1.2x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $3.5x10^{-5}$ | 0.02 | $2.8x10^{-4}$ | $3.0 x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.0 | 1,900 | 1,900 | None | $5.8x10^{-6}$ | $2.5x10^{-3}$ | $5.8x10^{-6}$ | $1.3x10^{-6}$ | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.0 | 7,600 | 7,600 | None | $2.5x10^{-4}$ | 0.11 | $2.4x10^{-6}$ | $1.4x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.2x10^{-4}$ | $3.1x10^{-3}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; PX 1992a:10; L.M. Paradee, 1992.

**TABLE E.3.4–24.—*Risk Assessments from Exposure to Hazardous Chemicals from Modular High Temperature Gas-Cooled Reactor Operation at Pantex Plant***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.7x10^{-5}$ | $7.3x10^{-3}$ | $2.5x10^{-7}$ | $2.7x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $6.2x10^{-6}$ | $2.7x10^{-3}$ | $1.3x10^{-7}$ | $1.4x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.7x10^{-5}$ | $7.3x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $6.2x10^{-6}$ | $2.7x10^{-3}$ | $3.5x10^{-6}$ | $1.0x10^{-5}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.00 | 1,900 | 1,900 | None | $1.9x10^{-6}$ | $8.2x10^{-4}$ | $1.9x10^{-6}$ | $4.3x10^{-7}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $5.8x10^{-6}$ | $1.5x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentration) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; PX 1992a:10.

**TABLE E.3.4–25.—*Risk Assessments from Exposure to Hazardous Chemicals from Advanced Light Water Reactor Operation at Pantex Plant***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetone | 10.5 | 1,800 | 1,800 | None | $5.8x10^{-5}$ | 0.03 | $5.6x10^{-6}$ | $1.4x10^{-5}$ | 0 | 0 |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.9x10^{-5}$ | $8.1x10^{-3}$ | $2.8x10^{-7}$ | $3.0x10^{-6}$ | 0 | 0 |
| Ammonia | 0.1 | 27 | 17 | None | $3.1x10^{-5}$ | 0.01 | $3.1x10^{-4}$ | $4.9x10^{-4}$ | 0 | 0 |
| Ethanol | 46.1 | 1,900 | 1,880 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $1.5x10^{-7}$ | $1.6x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.9x10^{-5}$ | $8.1x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $4.0x10^{-6}$ | $1.2x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $4.1x10^{-4}$ | 0.02 | $3.3x10^{-3}$ | $3.5x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.0 | 1,900 | 1,900 | None | $1.3x10^{-4}$ | $5.8x10^{-2}$ | $1.3x10^{-4}$ | $3.0x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.8x10^{-3}$ | $4.1x10^{-3}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.

[b] Hazard Quotient for MEI: boundary annual emissions/reference concentration.

[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/permissible exposure limit.

[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

[f] Hazard Index: sum of individual hazard quotients.

[g] Total Cancer Risk: sum of individual cancer risks.

Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; PX 1992a:10; L.M. Pardee, 1992; FDI Nov. 4,1994 Log #FO-94-0354.

**TABLE E.3.4–26.—*Risk Assessments from Exposure to Hazardous Chemicals from Accelerator Production of Tritium Operation at Pantex Plant***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.9x10^{-3}$ | $8.1x10^{-3}$ | $2.8x10^{-5}$ | $3.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $1.5x10^{-7}$ | $1.6x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.9x10^{-3}$ | $8.1x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $4.0x10^{-6}$ | $1.2x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.2x10^{-5}$ | $1.6x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.

[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.

[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.

[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).

[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).

[f] Hazard Index: sum of individual hazard quotients.

[g] Total Cancer Risk: sum of individual cancer risks.

Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; PX 1992a:10; L.M. Paradee, 1992.

TABLE E.3.4–27.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Operation at Pantex Plant*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.9x10^{-3}$ | $8.1x10^{-3}$ | $2.8x10^{-5}$ | $3.0x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $1.5x10^{-7}$ | $1.6x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.9x10^{-3}$ | $8.1x10^{-3}$ | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $6.9x10^{-6}$ | $3.0x10^{-3}$ | $4.0x10^{-6}$ | $1.2x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.2x10^{-5}$ | $1.6x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; FDI 1994h; SNL 1995a; L.M. Paradee, 1992; PX 1992a:10.

**TABLE E.3.4–28.—*Risk Assessments from Exposure to Hazardous Chemicals at Pantex Plant–Summary Hazard Index and Total Cancer Risk***

| Technology[a] | Hazard Index | | Total Cancer Risk | |
|---|---|---|---|---|
| | Boundary MEI[b, c] Annual | Worker 100 Meters 8 Hours[b] | Boundary MEI[d, e] Annual | Worker 100 Meters 8 Hours[d, f] |
| No Action | 0.030 | 0.49 | $1.1 \times 10^{-5}$ | 0.010 |
| Tritium Recycle | $3.2 \times 10^{-5}$ | $1.6 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor | $3.2 \times 10^{-4}$ | $3.1 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor and Tritium Recycling | $3.6 \times 10^{-4}$ | $3.1 \times 10^{-3}$ | 0 | 0 |
| Heavy Water Reactor, Tritium Recycling, and No Action | 0.031 | 0.49 | $1.1 \times 10^{-5}$ | 0.01 |
| Modular High Temperature Gas-Cooled Reactor | $5.8 \times 10^{-6}$ | $1.5 \times 10^{-5}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor and Tritium Recycling | $3.8 \times 10^{-5}$ | $3.1 \times 10^{-5}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor, Tritium Recycling, and No Action | 0.03 | 0.49 | $1.1 \times 10^{-5}$ | 0.01 |
| Advanced Light Water Reactor | $3.8 \times 10^{-3}$ | $4.1 \times 10^{-3}$ | 0 | 0 |
| Advanced Light Water Reactor and Tritium Recycling | $3.8 \times 10^{-3}$ | $4.1 \times 10^{-3}$ | 0 | 0 |
| Advanced Light Water Reactor, Tritium Recycling, and No Action | 0.034 | 0.49 | $1.1 \times 10^{-5}$ | 0.01 |
| Accelerated Production of Tritium | $3.2 \times 10^{-5}$ | $1.6 \times 10^{-5}$ | 0 | 0 |
| Accelerated Production of Tritium and Tritium Recycling | $6.4 \times 10^{-5}$ | $3.2 \times 10^{-5}$ | 0 | 0 |
| Accelerated Production of Tritium, Tritium Recycling and No Action | 0.030 | 0.49 | $1.1 \times 10^{-5}$ | 0.01 |

[a] Combined Hazard Index and total cancer risk for these alternatives.
[b] MEI: maximally exposed individual of the public.
[c] Hazard Index: sum of individual Hazard Quotient.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Total Cancer Risk: sum of individual cancer risks.
[f] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (slope factor).
Source: Calculated from model data derived from DOE 1995d; DOE 1995e; DOE 1995f; DOE 1995g; SNL 1995a; PX 1992a:10; FDI 1994h; FDI Nov. 4, 1994 Log # FO-94-0354.

**TABLE E.3.4–29.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Savannah River Site* [Page 1 of 2]**

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acrolein | 0.00002 | 0.25 | 0.23 | None | $1.6x10^{-6}$ | $2.1x10^{-3}$ | 0.08 | 0.01 | 0 | 0 |
| Acrylonitrile | 0.002 | 4.42 | 4.3 | 0.24 | $1.6x10^{-6}$ | $2.1x10^{-3}$ | $7.8x10^{-4}$ | $4.8x10^{-4}$ | $1.1x10^{-7}$ | $2.0x10^{-5}$ |
| Antimony | 0.0000139 | 0.5 | 0.5 | None | $9.2x10^{-7}$ | $1.2x10^{-3}$ | 0.07 | $2.5x10^{-3}$ | 0 | 0 |
| Benzene | 0.783 | 3.25 | 32.0 | 0.029 | $2.3x10^{-3}$ | 3.1 | $2.9x10^{-3}$ | 0.95 | $1.9x10^{-5}$ | $3.5x10^{-3}$ |
| Cadmium | 0.0005 | 0.2 | 0.05 | None | $9.2x10^{-7}$ | $1.3x10^{-3}$ | $1.8x10^{-3}$ | $6.3x10^{-3}$ | 0 | 0 |
| Cadmium oxide | 0.0025 | 0.1 | 0.05 | None | $1.1x10^{-6}$ | $1.4x10^{-3}$ | $4.2x10^{-4}$ | 0.014 | 0 | 0 |
| Chlorine | 0.039 | 1.5 | 1.0 | None | $1.2x10^{-4}$ | 0.16 | $3.1x10^{-3}$ | 0.11 | 0 | 0 |
| 2,4-Dinitrololuene | 0.0069 | 1.5 | 0.15 | None | $1.8x10^{-5}$ | 0.03 | $2.7x10^{-3}$ | 0.02 | 0 | 0 |
| Dioctyl phthalate | 0.07 | 5.0 | 5.0 | 0.014 | $2.1x10^{-6}$ | $2.9x10^{-3}$ | $3.1x10^{-5}$ | $5.8x10^{-4}$ | $8.6x10^{-9}$ | $1.6x10^{-6}$ |
| Ethyl benzene | 1.0 | 435.0 | 434.0 | None | $2.1x10^{-5}$ | 0.03 | $2.1x10^{-5}$ | $6.7x10^{-5}$ | 0 | 0 |
| Ethylene glycol | 0.2 | 740.0 | 18.0 | None | $8.1x10^{-6}$ | 0.01 | $4.1x10^{-5}$ | $1.5x10^{-5}$ | 0 | 0 |
| Formic acid | 6.994 | 9.0 | 9.4 | None | $2.9x10^{-5}$ | 0.04 | $4.2x10^{-6}$ | $4.4x10^{-3}$ | 0 | 0 |
| Hexane | 0.2 | 1,800.0 | 176.0 | None | $4.1x10^{-6}$ | $5.5x10^{-3}$ | $2.0x10^{-5}$ | $3.1x10^{-6}$ | 0 | 0 |
| Hydrogen chloride | 0.007 | 7.0 | 7.0 | None | $2.9x10^{-3}$ | 3.9 | 0.41 | 0.55 | 0 | 0 |
| Hydrogen sulfide | 0.0009 | 14.0 | 14.0 | None | $8.3x10^{-5}$ | 0.11 | 0.09 | $8.1x10^{-3}$ | 0 | 0 |
| Manganese | 0.005 | 1.0 | 2.0 | None | $6.3x10^{-6}$ | $8.5x10^{-3}$ | $1.3x10^{-3}$ | $8.5x10^{-3}$ | 0 | 0 |
| Mercury | 0.0003 | 0.05 | 0.05 | None | $3.2x10^{-6}$ | $4.3x10^{-3}$ | 0.01 | 0.09 | 0 | 0 |
| Methanol | 1.75 | 260.0 | 200.0 | None | $6.4x10^{-6}$ | $8.6x10^{-3}$ | $3.6x10^{-6}$ | $3.3x10^{-5}$ | 0 | 0 |
| Methylene chloride | 3.0 | 1,765.0 | 177.0 | 0.0075 | $2.2x10^{-5}$ | 0.03 | $7.3x10^{-6}$ | $1.7x10^{-5}$ | $4.7x10^{-8}$ | $8.6x10^{-6}$ |
| Methyl ethyl ketone (MEK) | 1.0 | 590.0 | 590.0 | None | $8.1x10^{-5}$ | 0.11 | $8.1x10^{-5}$ | $1.9x10^{-4}$ | 0 | 0 |
| Methyl tert-butyl ether | 0.2 | 20.0 | | None | $3.1x10^{-5}$ | 0.04 | $1.6x10^{-4}$ | $2.1x10^{-3}$ | 0 | 0 |
| Methyl isobutyl ketone (MIK) | 0.05 | 205.0 | 205.0 | None | $4.2x10^{-5}$ | 0.06 | $8.4x10^{-4}$ | $2.8x10^{-4}$ | 0 | 0 |
| Nickel | 0.02 | 1.0 | 1.0 | 0.84 | $4.3x10^{-6}$ | $5.8x10^{-3}$ | $2.2x10^{-4}$ | $5.8x10^{-3}$ | $1.0x10^{-6}$ | $1.9x10^{-4}$ |
| Nickel oxide | 0.0012 | 0.1 | 0.1 | None | $9.2x10^{-7}$ | $1.2x10^{-3}$ | $7.7x10^{-4}$ | 0.01 | 0 | 0 |
| Nitric acid | 0.123 | 5.0 | 5.0 | None | $4.8x10^{-5}$ | 0.06 | $3.9x10^{-4}$ | 0.01 | 0 | 0 |
| Sodium hydroxide | 0.0489 | 2.0 | 2.0 | None | $6.3x10^{-6}$ | $8.6x10^{-3}$ | $1.3x10^{-4}$ | $4.3x10^{-3}$ | 0 | 0 |

**TABLE E.3.4–29.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action Operation at Savannah River Site* [Page 2 of 2]**

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Sulfuric acid | 0.0245 | 1.0 | 1.0 | None | $9.5x10^{-7}$ | $1.3x10^{-3}$ | $3.9x10^{-5}$ | $1.3x10^{-3}$ | 0 | 0 |
| Tetrachloroethylene (PERC) | 0.03496503 | 170.0 | 339.0 | None | $5.3x10^{-4}$ | 0.72 | $1.5x10^{-2}$ | $4.2x10^{-3}$ | 0 | 0 |
| Toluene | 0.4 | 375.0 | 377.0 | None | $2.8x10^{-5}$ | 0.04 | $7.1x10^{-5}$ | $1.0x10^{-4}$ | 0 | 0 |
| 1,1,1-Trichloroethane (111-TCA) | 1.0 | 1,900.0 | 1,900.0 | None | $2.2x10^{-5}$ | 0.03 | $2.2x10^{-5}$ | $1.6x10^{-5}$ | 0 | 0 |
| Trichloroethylene (TCE) | 0.046 | 270.0 | 270.0 | 0.006 | $1.8x10^{-4}$ | 0.24 | $3.9x10^{-3}$ | $9.0x10^{-4}$ | $3.1x10^{-7}$ | $5.6x10^{-5}$ |
| Trichloromethane (chloroform) | 0.03497 | 240.0 | 9.78 | 0.081 | $5.2x10^{-4}$ | 0.70 | $1.5x10^{-2}$ | $2.9x10^{-3}$ | $1.2x10^{-5}$ | $2.2x10^{-3}$ |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113) | 105.0 | 7,600.0 | 7,670.0 | None | $1.6x10^{-6}$ | $2.1x10^{-3}$ | $1.5x10^{-8}$ | $2.8x10^{-7}$ | 0 | 0 |
| Xylene | 7.0 | 435.0 | 435.0 | None | $3.8x10^{-4}$ | 0.51 | $5.4x10^{-5}$ | $1.2x10^{-3}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | 0.70 | 1.8 | | |
| **Total Cancer Risk[g]** | | | | | | | | | $3.2x10^{-5}$ | $5.9x10^{-3}$ |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

TABLE E.3.4–30.—*Risk Assessments from Exposure to Hazardous Chemicals from Heavy Water Reactor Operation at Savannah River Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-5}$ | 0.01 | $1.6x10^{-7}$ | $5.3x10^{-6}$ | 0 | 0 |
| Ethanol | 46.1 | 1,900 | 1,900 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $8.5x10^{-8}$ | $2.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-5}$ | 0.01 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 260 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $2.2x10^{-6}$ | $2.0x10^{-5}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.0 | 1,900 | 1,900 | None | $1.2x10^{-6}$ | $1.6x10^{-3}$ | $1.2x10^{-6}$ | $8.5x10^{-7}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $3.7x10^{-6}$ | $2.9x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

**TABLE E.3.4–31.**—*Risk Assessments from Exposure to Hazardous Chemicals from Modular High Temperature Gas-Cooled Reactor Operation at Savannah River Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $4.0x10^{-6}$ | $6.0x10^{-5}$ | $6.1x10^{-8}$ | $2.2x10^{-8}$ | 0 | 0 |
| Ammonia | 0.01 | 27 | 17 | None | $1.1x10^{-6}$ | $1.6x10^{-5}$ | $1.1x10^{-4}$ | $6.1x10^{-7}$ | 0 | 0 |
| Ethanol | 46.1 | 1,900 | 1,900 | None | $3.3x10^{-5}$ | $4.8x10^{-4}$ | $7.3x10^{-7}$ | $2.5x10^{-7}$ | 0 | 0 |
| Methanol | 1.75 | 260 | 260 | None | $3.3x10^{-5}$ | $4.8x10^{-4}$ | $1.9x10^{-5}$ | $1.8x10^{-6}$ | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.0 | 1,900 | 1,900 | None | $1.4x10^{-6}$ | $2.1x10^{-5}$ | $1.4x10^{-6}$ | $1.1x10^{-8}$ | 0 | 0 |
| Trichlorotrifluoroethane (Freon 113) | 105.0 | 7,600 | 7,670 | None | $1.5x10^{-4}$ | $2.3x10^{-3}$ | $1.4x10^{-6}$ | $3.0x10^{-7}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $1.3x10^{-4}$ | $3.0x10^{-6}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

**TABLE E.3.4–32.—*Risk Assessments from Exposure to Hazardous Chemicals from Advanced Light Water Reactor at Savannah River Site***

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetone | 10.5 | 1,800 | 1,800 | None | $3.7x10^{-5}$ | 0.05 | $3.5x10^{-6}$ | $2.8x10^{-5}$ | 0 | 0 |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-5}$ | 0.01 | $1.6x10^{-7}$ | $5.3x10^{-6}$ | 0 | 0 |
| Ammonia | 0.01 | 27 | 17 | None | $1.9x10^{-5}$ | 0.03 | $1.9x10^{-3}$ | $9.7x10^{-4}$ | 0 | 0 |
| Ethanol | 46.1 | 1,900 | 1,900 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $8.5x10^{-8}$ | $2.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-5}$ | 0.01 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 260 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $2.2x10^{-6}$ | $2.0x10^{-5}$ | 0 | 0 |
| Nitric acid | 0.123 | 5 | 5 | None | $2.6x10^{-4}$ | 0.35 | $2.1x10^{-3}$ | 0.07 | 0 | 0 |
| 1,1,1-Trichloroethane (TCA) | 1.0 | 1,900 | 1,900 | None | $8.5x10^{-5}$ | 0.11 | $8.5x10^{-5}$ | $6.0x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $4.1x10^{-3}$ | 0.071 | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

TABLE E.3.4–33.—*Risk Assessments from Exposure to Hazardous Chemicals from Accelerator Production of Tritium Operation at Savannah River Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Reference Concentration ($mg/m^3$)** | **Permissible Exposure Limit ($mg/m^3$)** | **Threshold Limit Value ($mg/m^3$)** | **Slope Factor (mg-kg/day)** | **Boundary MEI[a] Annual ($mg/m^3$)** | **Worker 100 Meters 8 Hours ($mg/m^3$)** | **Boundary MEI[a,b] Annual** | **Worker 100 Meters 8 Hours[c]** | **Boundary MEI[a,d] Annual** | **Worker 100 Meters 8 Hours[e]** |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-5}$ | 0.01 | $1.6x10^{-7}$ | $5.3x10^{-6}$ | 0 | 0 |
| Ethanol | 46.1 | 1,900 | 1,900 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $8.5x10^{-8}$ | $2.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-5}$ | 0.01 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 260 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $2.2x10^{-6}$ | $2.0x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $2.5x10^{-6}$ | $2.8x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

TABLE E.3.4–34.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Upgrade Operation at Savannah River Site*

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acetylene | 66.28 | 2,708 | 2,708 | None | $1.1x10^{-5}$ | $1.4x10^{-2}$ | $1.6x10^{-7}$ | $5.3x10^{-6}$ | 0 | 0 |
| Ethanol | 46.10 | 1,900 | 1,880 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $8.5x10^{-8}$ | $2.8x10^{-6}$ | 0 | 0 |
| Methane (simple asphyxiant) | None | None | None | None | $1.1x10^{-5}$ | 0.01 | 0 | 0 | 0 | 0 |
| Methanol | 1.75 | 260 | 200 | None | $3.9x10^{-6}$ | $5.3x10^{-3}$ | $2.2x10^{-6}$ | $2.0x10^{-5}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | $2.5x10^{-6}$ | $2.8x10^{-5}$ | | |
| **Total Cancer Risk[g]** | | | | | | | | | 0 | 0 |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/Reference Concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/Permissible Exposure Limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

TABLE E.3.4–35.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Phaseout Function at Savannah River Site* [Page 1 of 2]

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Acrolein | 0.00002 | 0.25 | 0.23 | None | $1.6x10^{-6}$ | $2.1x10^{-3}$ | $7.8x10^{-2}$ | 0.01 | 0 | 0 |
| Acrylonitrile | 0.002 | 4.42 | 4.3 | 0.24 | $1.6x10^{-6}$ | $2.1x10^{-3}$ | $7.8x10^{-4}$ | $4.8x10^{-4}$ | $1.1x10^{-7}$ | $2.0x10^{-5}$ |
| Antimony | 0.00001 | 0.50 | 0.5 | None | $9.2x10^{-7}$ | $1.2x10^{-3}$ | $6.6x10^{-2}$ | $2.5x10^{-3}$ | 0 | 0 |
| Benzene | 0.783 | 3.25 | 32.0 | 0.029 | $2.3x10^{-3}$ | 3.1 | $2.9x10^{-3}$ | 0.95 | $1.9x10^{-5}$ | $3.5x10^{-3}$ |
| Cadmium | 0.0005 | 0.2 | 0.05 | None | $9.2x10^{-7}$ | $1.3x10^{-3}$ | $1.8x10^{-3}$ | $6.3x10^{-3}$ | 0 | 0 |
| Cadmium oxide | 0.0025 | 0.1 | 0.05 | None | $1.1x10^{-6}$ | $1.4x10^{-3}$ | $4.2x10^{-4}$ | 0.01 | 0 | 0 |
| Chlorine | 0.039 | 1.5 | 1.5 | None | $1.2x10^{-4}$ | 0.16 | $3.1x10^{-3}$ | 0.11 | 0 | 0 |
| 2,4-Dinitrotoluene | 0.0069 | 1.5 | 0.15 | None | $1.8x10^{-5}$ | 0.03 | $2.7x10^{-3}$ | 0.02 | 0 | 0 |
| Dioctyl phthalate | 0.07 | 5.0 | 5.0 | 0.014 | $2.1x10^{-6}$ | $2.9x10^{-3}$ | $3.1x10^{-5}$ | $5.8x10^{-4}$ | $8.6x10^{-9}$ | $1.6x10^{-6}$ |
| Ethyl benzene | 1.0 | 435.0 | 434.0 | None | $2.1x10^{-5}$ | 0.03 | $2.1x10^{-5}$ | $6.7x10^{-5}$ | 0 | 0 |
| Ethylene glycol | 0.2 | 740.0 | 18.0 | None | $8.1x10^{-6}$ | 0.01 | $4.1x10^{-5}$ | $1.5x10^{-5}$ | 0 | 0 |
| Formic acid | 6.994 | 9.0 | 9.4 | None | $2.9x10^{-5}$ | 0.04 | $4.2x10^{-6}$ | $4.4x10^{-3}$ | 0 | 0 |
| Hexane | 0.2 | 1,800.0 | 176.0 | None | $4.1x10^{-6}$ | $5.5x10^{-3}$ | $2.0x10^{-5}$ | $3.1x10^{-6}$ | 0 | 0 |
| Hydrogen chloride | 0.007 | 7.0 | 7.0 | None | $2.9x10^{-3}$ | 3.9 | 0.41 | 0.55 | 0 | 0 |
| Hydrogen sulfide | 0.0009 | 14.0 | 14.0 | None | $8.3x10^{-5}$ | 0.11 | 0.09 | $8.1x10^{-3}$ | 0 | 0 |
| Manganese | 0.005 | 1.0 | 2.0 | None | $6.3x10^{-6}$ | $8.5x10^{-3}$ | $1.3x10^{-3}$ | $8.5x10^{-3}$ | 0 | 0 |
| Mercury | 0.0003 | 0.05 | 0.05 | None | $3.2x10^{-6}$ | $4.3x10^{-3}$ | 0.01 | 0.09 | 0 | 0 |
| Methanol | 1.75 | 260.0 | 200.0 | None | $6.2x10^{-6}$ | $8.5x10^{-3}$ | $3.6x10^{-6}$ | $3.3x10^{-5}$ | 0 | 0 |
| Methylene chloride | 3.0 | 1,765.0 | 177.0 | 0.0075 | $2.2x10^{-5}$ | 0.030 | $7.3x10^{-6}$ | $1.7x10^{-5}$ | $4.7x10^{-8}$ | $8.6x10^{-6}$ |
| Methyl ethyl ketone (MEK) | 1.0 | 590.0 | 590.0 | 0 | $8.1x10^{-5}$ | 0.11 | $8.1x10^{-5}$ | $1.8x10^{-4}$ | 0 | 0 |
| Methyl tert-butyl ether | 0.2 | 20.0 | | 0 | $3.1x10^{-5}$ | 0.04 | $1.6x10^{-4}$ | $2.1x10^{-3}$ | 0 | 0 |
| Methyl isobutyl ketone (MIK) | 0.05 | 205.0 | 205.00 | 0 | $4.2x10^{-5}$ | 0.06 | $8.4x10^{-4}$ | $2.8x10^{-4}$ | 0 | 0 |
| Nickel | 0.02 | 1.0 | 1.0 | 0.84 | $4.3x10^{-6}$ | $5.8x10^{-3}$ | $2.2x10^{-4}$ | $5.8x10^{-3}$ | $1.0x10^{-6}$ | $1.9x10^{-4}$ |
| Nickel oxide | 0.0012 | 0.1 | 0.1 | 0 | $9.2x10^{-7}$ | $1.2x10^{-3}$ | $7.7x10^{-4}$ | 0.01 | 0 | 0 |
| Nitric acid | 0.123 | 5.0 | 5.0 | 0 | $4.8x10^{-5}$ | 0.06 | $3.9x10^{-4}$ | 0.01 | 0 | 0 |

**TABLE E.3.4–35.—*Risk Assessments from Exposure to Hazardous Chemicals from Tritium Recycling Phaseout Function at Savannah River Site* [Page 2 of 2]**

| | Regulated Exposure Limits/Risk Factors | | | | Emissions Inventory | | Hazard Quotient | | Cancer Risk | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Reference Concentration ($mg/m^3$) | Permissible Exposure Limit ($mg/m^3$) | Threshold Limit Value ($mg/m^3$) | Slope Factor (mg-kg/day) | Boundary MEI[a] Annual ($mg/m^3$) | Worker 100 Meters 8 Hours ($mg/m^3$) | Boundary MEI[a,b] Annual | Worker 100 Meters 8 Hours[c] | Boundary MEI[a,d] Annual | Worker 100 Meters 8 Hours[e] |
| Sodium hydroxide | 0.0489 | 2.0 | 2.0 | None | $6.3x10^{-6}$ | $8.6x10^{-3}$ | $1.3x10^{-4}$ | $4.3x10^{-3}$ | 0 | 0 |
| Sulfuric acid | 0.0245 | 1.0 | 1.0 | None | $9.5x10^{-7}$ | $1.3x10^{-3}$ | $3.9x10^{-5}$ | $1.3x10^{-3}$ | 0 | 0 |
| Tetrachloroethylene (PERC) | 0.03497 | 170.0 | 339.0 | None | $5.3x10^{-4}$ | 0.72 | 0.02 | $4.2x10^{-3}$ | 0 | 0 |
| 1,1,1-Trichloroethane (111-TCA) | 1.0 | 1,900.0 | 1,900.0 | None | $2.2x10^{-5}$ | 0.03 | $2.2x10^{-5}$ | $1.6x10^{-5}$ | 0 | 0 |
| Trichloroethylene (TCE) | 0.046 | 270.0 | 270.0 | 0.006 | $1.8x10^{-4}$ | 0.24 | $3.9x10^{-3}$ | $9.0x10^{-4}$ | $3.1x10^{-7}$ | $5.6x10^{-5}$ |
| Trichloromethane (Chloroform) | 0.03497 | 240.0 | 9.78 | 0.081 | $5.2x10^{-4}$ | 0.70 | 0.02 | $2.9x10^{-3}$ | $1.2x10^{-5}$ | $2.2x10^{-3}$ |
| 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113) | 105.0 | 7,600.0 | 7,670.0 | None | $1.6x10^{-5}$ | $2.1x10^{-3}$ | $1.5x10^{-7}$ | $2.8x10^{-7}$ | 0 | 0 |
| Toluene | 0.4 | 375.0 | 377.0 | None | $2.8x10^{-5}$ | 0.04 | $7.1x10^{-5}$ | $1.0x10^{-4}$ | 0 | 0 |
| Xylene | 7.0 | 435.0 | 435.0 | None | $3.8x10^{-4}$ | 0.51 | $5.4x10^{-5}$ | $1.2x10^{-3}$ | 0 | 0 |
| **Hazard Index[f]** | | | | | | | 0.7 | 1.8 | | |
| **Total Cancer Risk[g]** | | | | | | | | | $3.2x10^{-5}$ | $5.9x10^{-3}$ |

[a] MEI: maximally exposed individual of the public.
[b] Hazard Quotient for MEI: boundary annual emissions/reference concentration.
[c] Hazard Quotient for Workers: 100-meter, 8-hr emissions/permissible exposure limit.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (slope factor).
[f] Hazard Index: sum of individual hazard quotients.
[g] Total Cancer Risk: sum of individual cancer risks.
Source: Calculated from modeled data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SR DOE 1995a; SRS 1993a:3.

**TABLE E.3.4–36.—*Risk Assessments from Exposure to Hazardous Chemicals at Savannah River Site–Summary Hazard Index and Total Cancer Risk***

| Technology[a] | Hazard Index | | Total Cancer Risk | |
|---|---|---|---|---|
| | Boundary MEI[b, c] Annual | Worker 100 Meters 8 Hours[b] | Boundary MEI[d, e] Annual | Worker 100 Meters 8 Hours[d, f] |
| No Action | 0.70 | 1.8 | $3.2 \times 10^{-5}$ | $5.9 \times 10^{-3}$ |
| Tritium Recycling Upgrade | $2.5 \times 10^{-6}$ | $2.8 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor | $3.7 \times 10^{-6}$ | $2.9 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor and Tritium Recycling Upgrade | $6.1 \times 10^{-6}$ | $5.8 \times 10^{-5}$ | 0 | 0 |
| Heavy Water Reactor, Tritium Recycling Upgrade and No Action | 0.70 | 1.8 | $3.2 \times 10^{-5}$ | $5.9 \times 10^{-3}$ |
| Modular High Temperature Gas-Cooled Reactor | $1.3 \times 10^{-4}$ | $3.0 \times 10^{-6}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor and Tritium Recycling Upgrade | $1.4 \times 10^{-4}$ | $3.1 \times 10^{-5}$ | 0 | 0 |
| Modular High Temperature Gas-Cooled Reactor, Tritium Recycling Upgrade, and No Action | 0.70 | 1.8 | $3.2 \times 10^{-5}$ | $5.9 \times 10^{-3}$ |
| Advanced Light Water Reactor | $4.1 \times 10^{-3}$ | 0.071 | 0 | 0 |
| Advanced Light Water Reactor and Tritium Recycling Upgrade | $4.1 \times 10^{-3}$ | 0.071 | 0 | 0 |
| Advanced Light Water Reactor, Tritium Recycling Upgrade, and No Action | 0.70 | 1.9 | 0 | 0 |
| Accelerated Production of Tritium | $2.5 \times 10^{-6}$ | $2.8 \times 10^{-5}$ | 0 | 0 |
| Accelerated Production of Tritium and Tritium Recycling Upgrade | $4.9 \times 10^{-6}$ | $5.7 \times 10^{-5}$ | 0 | 0 |
| Accelerated Production of Tritium, Tritium Recycling Upgrade, and No Action | 0.70 | 1.8 | $3.2 \times 10^{-5}$ | $5.9 \times 10^{-3}$ |
| Tritium Recycling Only | 0.70 | 1.8 | $3.2 \times 10^{-5}$ | $5.9 \times 10^{-3}$ |

[a] Combined Hazard Index and total cancer risk for these alternatives.
[b] MEI: maximally exposed individual of the public.
[c] Hazard Index: sum of individual Hazard Quotient.
[d] Cancer Risk for MEI: (emissions concentrations) x (0.286 [converts concentrations to doses]) x (slope factor).
[e] Total Cancer Risk: sum of individual cancer risks.
[f] Cancer Risk for Workers: (emissions for 8-hr) x (0.286 [converts concentrations to doses]) x (slope factor).
Source: Calculated from model data derived from DOE 1995d; DOE 1995e; DOE 1995f; FDI 1994h; SNL 1995a; SRS 1993a:3.

## E.4 HEALTH EFFECTS STUDIES: EPIDEMIOLOGY

Various epidemiologic studies have been conducted at some of the sites evaluated in this PEIS because of the concern with the health effects of nuclear research, and the manufacture and testing of nuclear weapons. These studies are summarized below. With a few exceptions most epidemiologic studies of the populations living near the site have been descriptive in nature and are what epidemiologists refer to as ecologic or correlational studies. Occupational epidemiologic studies, studies of workers, have been mostly analytical. The various epidemiologic studies, along with their assumptions and limitations, are described in section E.4.1.

### E.4.1 Background

Nuclear weapons research and manufacture and consequent exposure occurred since the late 1930's and early 1940's. Very little knowledge was available at the time on the potential health effects from radiation exposure. As with many other chemicals, exposure levels to nuclear elements have changed over time with higher levels occurring in the early days of research and manufacture. Epidemiologic studies have been conducted to identify adverse health effects associated with nuclear use. Different epidemiologic methods have been used to assess these health effects; however, the epidemiologic methods for assessing occupational exposures have also evolved over time. For example, the use of multivariate methods for data analysis is a more recent phenomenon. The multivariate methods are more powerful in identifying causality than the ecologic and descriptive methods that were used more frequently just a few years ago. Thus, the review of the epidemiologic literature and the resulting findings basically reflect this change in study design over time.

#### E.4.1.1 *Study Designs*

Studies that have been conducted to assess the health effects resulting from exposure to nuclear radiation include ecologic studies, cohort studies, and case-control studies, which includes the nested case-control design.

The unit of observation in *Ecological or Correlational Studies* is a group of people rather than an individual (Rothman 1986a). Examples of groups may include classes in a school, factory workers, residents of a city, county, or nation. The health effects measured are frequently limited to the incidence (newly diagnosed cases) or mortality rates because these health indicators are readily available for the unit population under consideration. Exposure is defined as residence in the unit of observation and every person in the unit is assumed to be equally exposed whether they have resided in the unit for a very short time period or a very long time period or whether they even resided in the unit at the time of exposure. Exposure is also assumed to be limited to the unit of observation, a fact that may or may not be true for the 5 candidate sites because of the potential downwind emissions considered to be an important factor in population exposure. The unit of observation for the ecologic studies conducted around the PEIS sites is the county(ies) where the facility is located. Rates in these counties are compared to rates in counties farther away from the site. Because measurements are averaged over populations and because the measures of exposure are only proxies, the ecologic studies tend to attenuate any real associations between exposure and risks unless the risks of disease are very large. No control of confounding is possible in these studies, except for general population rates such as income, race, or crowding. Ecologic studies, however, are frequently used as an overall screening method to assess whether a major health problem exists. Ecologic studies are also relatively inexpensive to conduct compared to other epidemiologic studies because they use readily available data (mortality rates, cancer registry rates, census data) and can be done relatively quickly. Most population-based studies at the PEIS sites have been ecologic (correlational) studies.

The cohort (follow-up) method has been most frequently used to date for the analysis of occupational exposures. Cohort studies include the entire available study population, although some populations may be limited by employment or termination dates (RMOE 1989a). A cohort study requires the enumeration and follow-up of a population of individuals who are known to be exposed or not exposed to an agent of interest (although exposure measurements can be very general or very specific). Cohort follow-up studies can be prospective, where the cohort is identified at the beginning of the study and followed over time, or historical, where the cohort of

individuals, most frequently workers, is enumerated as of some time in the past and the health of the cohort is assessed over historical time to estimate disease rates. Most cohort follow-up studies conducted at the PEIS sites have been historical cohort studies. Traditionally, overall and cause-specific mortality rates have been assessed. More recently, overall and cause-specific cancer incidence (newly diagnosed) rates have also been assessed. Use of incidence rates, however, is limited to their availability. Rates in the exposed cohort are compared to those observed in a nonexposed population such as the national or regional populations (Standard Mortality or Incidence Ratios), or with subgroups of the cohort classified according to exposure type or level (Relative risks, risk ratio, rate ratio). The advantage of the historical cohort design is that it allows follow-up of a large number of individuals (thousands) over a long period of time (years) which would not be feasible for prospective cohort studies (individuals could outlive the investigator). But the method also has its drawbacks. Past records are not easily available and may be incomplete or destroyed. Cohort studies are also expensive and time consuming since records for all subjects must be abstracted.

The case-control study design reduces cost and time by requiring that information be collected only for the cases and a sample of the cohort that generated the cases (the controls), thus mitigating the difficulties of following a large cohort over time. When used properly, case-control studies provide estimates of the relative risks (odds ratio) of cohort studies (RMOE 1989a). The problem with case-control studies is the identification of controls that are representative of the population that generated the cases. Some case-control studies have been used to study populations around some PEIS sites.

The nested case-control design avoids the problems of the general case-control study while taking advantage of its cost saving feature because of the limited number of individuals studied. In a nested case-control study, the enumerated cohort is restricted to the analysis of observed cases and a sample of other individuals free of the disease at the time when the disease in the cases occurred. Several nested case-control studies have been conducted among the workers at the PEIS sites (e.g., ORR). These studies provide estimates of the relative risks (odds ratios) from cohort studies, and the results can be generalized to the entire cohort.

### E.4.1.2 *Definitions*

Standardization: A method used to control the effects of age, gender, or other known differences when comparing two or more different populations. These methods are used to obtain expected numbers of cases. There are two main methods:

Direct Method: The disease rates in the study population are used and are multiplied by the number of individuals in the age-, gender-, or other grouping in the standard population to obtain the expected rates of disease for the study population if the study population had the same age-, gender-, or other characteristics of the standard population.

Indirect Method: Because of the small number of individuals in a study population the rates can be very unstable. When this happens, the standardization method of choice is the indirect method. The disease rates in the standard population are multiplied by the number of individuals in the age-, gender-, or other specific group in the study population to obtain the expected rate of disease in the study population if the study population had the same disease rates as the standard population given the study population's age, gender, or other distribution characteristics.

Standardized Mortality (Incidence) Ratio: The standard mortality ratio is the ratio of the number of events observed in the study group or population to the number that would be expected if the study group or population had the same rates as the standard (reference) population. These rates have been standardized to the same standard population distribution. Data from the United States population or state-specific populations are most frequently referenced when this rate is used. Standard mortality ratios are frequently used with ecologic and historical cohort follow-up studies. Lack of comparisons between standard mortality ratios from different populations and the healthy worker effect are two distinct disadvantages in using this rate.

Standardized Rate Ratio: A rate ratio in which the numerator and the denominator have been standardized to the same (standard) population distribution.

Relative Risk, Risk Ratio, Rate Ratio: The ratio of the risk of disease or death among the exposed to the risk among the unexposed. Also, the cumulative incidence rate in the exposed to the cumulative incidence rate in the unexposed.

Odd Ratio, also Cross-Product Ratio, and Relative Odds: The odds ratio is the ratio of the odds of getting the disease if exposed, to the odds of getting the disease if not exposed. Under certain conditions the Odd Ratio approximates the Rate Ratio.

Healthy Worker Effect: A phenomenon observed in studies of occupational diseases. Workers usually exhibit lower overall death or disease rates compared to the general population, due to the fact that the severely ill and disabled are excluded from employment. Rates from the general population may be inappropriate for comparison if this effect is not taken into consideration.

### E.4.2 Idaho National Engineering Laboratory

**Surrounding Communities.** A population-based mortality study, carried out by the National Cancer Institute (NIH 1990a; AMA 1991a), examined cancer mortality within a 50-mile radius around several nuclear facilities including INEL. The Idaho study counties included Bingham, Butte, and Jefferson Counties. No excess cancer mortality was observed in the population living in counties surrounding INEL when compared to the United States population, or to the population in the three control counties (Fremont, Cassia, Power, Madison MT, Broadwater MT, Custer, Twin Falls, Lemhi, and Oneida) for each study county, or when time trends were assessed. The study is limited by its correlational approach and the large size of the geographic areas (counties) used for surrogate exposure measurements.

The Idaho Department of Health and Welfare (Epidemiology and Health Statistics group) completed a different community-based epidemiologic cancer morbidity (1978-1987) and mortality (1950-1989) study of two additional counties (Minidoka and Clark) also within a 50-mile radius near INEL. Clark County lies northeast, and Minidoka County lies southwest of INEL. Clark County population was 880 in 1988, while the 1988 population for Minidoka County was 20,100 (IN DHW 1991a). Cancer death and incidence rates of the Minidoka and Clark populations were compared to those of the entire Idaho population. No differences in age-adjusted mortality rates were observed in either county. The overall annualized cancer death rate for Minidoka County was 314/100,000 compared to 311.3/100,000 for the state (IN DHW 1991b). The cancer death rate for Clark County was 517.3/100,000 but because of the very small number of people living in Clark County this death rate may be very unstable.

An excess risk was reported, however, for cancer-specific incidence rates. Clark County had an excess of newly diagnosed radiogenic and nonradiogenic cancers, but of these only breast (8 observed, 3.6 expected), which is radiogenic, and lip cancer in males (3 observed, 0.3 expected), which is not radiogenic, were statistically significant. The number of cases, however, was very small and the confidence intervals were wide. Minidoka County also had an excess in radiogenic and nonradiogenic incident cancers; however, only lip (23 observed, 8 expected) and corpus uteri (40 observed, 24.2 expected), both nonradiogenic cancers, reached statistical significance. Since exposure and dose data from INEL were not used for these studies, the excess in cancers are just as likely to be associated with competing causes such as farming and/or smoking and may not be associated with the INEL site specifically. Exposure-related excesses may also be masked due to the imprecise comparisons made, the use of the correlational approach as a surrogate for exposure measurement, the large size geographic areas considered, and the small sample size.

**Workers.** No occupational epidemiologic studies have been conducted at INEL to date, although the National Institute for Occupational Safety and Health is planning one in 1994. The Centers for Disease Control and Prevention, as a result of the Memorandum of Understanding with the Department of Health and Human Services of 1991, is currently conducting a dose reconstruction study in anticipation of future epidemiologic community studies.

### E.4.3 Nevada Test Site

**Surrounding Communities.** Because of the potential carcinogenic threat of radioactive fallout on the general population resulting from above-ground nuclear weapons testing, epidemiologic studies have attempted to assess the cancer incidence and

mortality among individuals living in the areas of potential fallout including areas in Utah. A series of ecological studies showed contradictory results in potentially exposed children. Lyon examined the cancer mortality (leukemia and other) of children living in high and low fallout areas between 1944 and 1975 (NEJM 1979a). Only children born between 1951 and 1958 (period of above-ground testing) were considered as highly exposed if they lived in one of the high-exposure areas at the time of death (Utah was exposed to 26 nuclear tests from the Nevada Test Site (NTS) between 1951 and 1958). Cancer cause was obtained from the death certificates and were separated into leukemias and others. Results show that although Utah children experience an overall cancer mortality rate lower than U.S. children as a whole, children living in high-fallout areas had more leukemia deaths than children living in low fallout areas. Other cancers occurred at the same rate in both high and low fallout areas. The high-risk fallout area identified by Lyon et al. was questioned by Beck and Krey (Science 1983a) who reconstructed the total $Cs^{137}$ inventory across the state of Utah (area near NTS). Their measurements showed that sections of northern Utah also had high levels of fallout and questioned the results of any comparisons made between residents of the North and those of the South. Land (Science 1984a) also re-examined cancer mortality reported by Lyon (NEJM 1979a) using the National Center for Health Statistics data which covered the period 1950 through 1978. The analyses examined a reported association between childhood leukemia and exposure to radioactive fallout from above-ground nuclear weapons tests in Nevada. The exposure group consisted of 17 rural counties in Utah which were downwind from the tests and the control group consisted of the remaining 12 northern counties of Idaho and no- or low-fallout regions outside Utah (Eastern Oregon and the State of Iowa). Although an excess of leukemia was reported for high exposure levels compared to low exposure levels, the data did not support a regional difference because leukemia rates were also significantly elevated in Oregon, an area of no fallout.

Another study that assessed the development of cancer among individuals potentially exposed to radioactive fallout has been reported by Rallison (HP 1990a). This study examined the thyroid cancer risk in a cohort of children born between 1947 and 1954 in two counties near the nuclear test sites, one in Utah and one in Nevada. A comparison group of Arizona children was also evaluated. The children (11 to 18 years of age) were examined between 1965 and 1968 for thyroid abnormalities and were re-examined in 1985 and 1986. Like the ecological studies, however, exposure was based on geopolitical boundaries. Children living in the nuclear testing area had a higher rate of thyroid cancer but the differences were not statistically significant. Some examined children currently living in the high-fallout area at the time of examination were later found to have been living outside the high-fallout area at the time of exposure.

A more definitive study (AMA 1984a) examined the cancer incidence in an area of radioactive fallout downwind from NTS. This study consisted of two parts: an analysis of all Utah Mormons and a personal interview of individuals residing in a high-fallout area. Cancer incidence data for all Utah Mormons was available and two 9-year periods (1958 to 1966 and 1972 to 1980) were selected for the study. The average annual age-adjusted cancer incidence rate was reported as 228/100,000 for all Utah Mormons between 1967 and 1975. The cancers statistically significant at the 1 percent probability level for all Utah Mormons during both time periods were cancers of the thyroid (standard incident ratio (SIR)) (SIR = 4.3-8.2), bone (SIR = 10.0-12.5), and leukemia (SIR = 5.28-3.5). The ratio of radiosensitive cancer to all other cancers was 53.3 percent higher in the early period (1958 to 1966) and 300 percent higher in the later period (1972 to 1980). The lower range of whole-body radiation associated with fallout symptoms in this study is about 50 rads.

Sixty percent of the 4,125 Mormons who were listed in the telephone directory in 1951 and in 1962 were located and interviewed in 1981. Information on personal habits, lifestyle, cancer, and reproduction was obtained for each family member. This study is one of the few where the investigators were able to interview the study subjects, where the reported cancers were verified, and where a comparable and appropriate comparison group was available. The cancer incidence was greater in this group compared to all Utah Mormons, but most cancers were reported in the period between 1958 and 1968 (stomach, leukemia, brain, and melanoma) and only a few (breast and lymphoma) were statistically significant in the later time period (1972 to 1980). This part of the study would have been more powerful if the

investigators had interviewed a comparable group of controls.

Cancers of all sites were significant at the 1 percent probability level for all groups studied and for all time periods under consideration.

Machado (AJE 1987a) examined the cancer mortality experience of a three-county region in southwestern Utah using a correlational cross sectional mortality study and compared the cancer mortality there with that from the rest of Utah. This study confirmed the excess leukemia reported by Johnson (AMA 1984a) but could not confirm the excess cancers at other sites. Because the studies have different designs they cannot easily be directly compared.

Archer (AEH 1987a) measured soil, milk, and bone strontium-90 levels to identify states with high, intermediate, and low fallout contamination. He then correlated the deaths from radiogenic and nonradiogenic leukemias with the time periods of above-ground nuclear testing both in the United States and Asia. The results show that leukemia deaths in children were higher in states with high exposure and lower in states with less exposure. He showed that leukemia deaths in children peaked approximately 5.5 years following nuclear testing peaks. The last leukemia peak in the United States occurred in 1968 to 1969, 5.5 years after the last year of a 3-year period of intensive testing in Asia. The increases were seen in the radiogenic leukemias (myeloid and acute leukemias), and not with "all other leukemias."

**Workers.** An excess number of leukemia cases was reported (9 cases, 3.5 expected) among the 3,224 men who participated in military maneuvers in 1957 at the time of the nuclear test explosion "Smoky" (AMA 1980a; AMA 1983a). The participants were located and queried on their health status, diseases, or hospitalizations as of December 1981. A next of kin was queried about cause of death for those participants who were deceased. Exposure information was available from film badges and ranged from 40 to 1,834 mrem. In the later report (AMA 1983a), the number of incident cases of leukemia had increased to 10 with 4 expected. No excess in "total cancers" was observed, however. In addition, four cases of polycythemia vera were reported where 0.2 was expected (AMA1984a). The excess in leukemia cancer incidence and mortality appear to be limited to the soldiers who participated in "Smoky." The excess was not observed in a National Research Council mortality study of soldiers exposed to five series of tests at two sites: Nevada Test Site (PLUMBBOB) and the Pacific Proving Ground (National 1985a). The NRC reported that the number of leukemia cases in "Smoky" was greater but the increase was considered nonsignificant when analyzed with the data from the other four tests.

Re-analysis of the National Research Council report on the *Mortality of Nuclear Weapons Test Participants* released on June 4, 1985, showed a 62-percent excess cancer among soldiers involved in the nuclear test explosion PLUMBBOB ("Smoky" was part of PLUMBBOB) who were exposed to 300 mrem or more (AJE 1987a). The excess was observed for leukemia and aleukemia as well as the other cancer group. The original analyses acknowledged the healthy worker bias when the expected mortality values were obtained from the general population but the method of analysis did not control for the problem in the original study. The reanalysis avoided the problem by considering a dose response analysis. Two exposure groups were considered: ≥300 mrem and <300 mrem. The excess was observed in the group exposed to more than 300 mrem. The reanalysis also reports an elevated risk of death from respiratory cancers for "Smoky" participants (Cancer Mortality Ratio = 2.28, $p < 0.01$) and an excess risk of "other" (Ratio = 1.75, $p < 0.01$) and "all cancers" (Ratio = 1.49, $p < 0.01$) for the other participants of "PLUMBBOB."

### E.4.4 Oak Ridge Reservation

More epidemiologic studies have been carried out to assess the health effects of the population living near or working at the ORR facilities in Tennessee than at any other site reviewed for the PEIS.

**Surrounding Communities.** The population-based National Cancer Institute mortality survey for selected nuclear facilities (NIH 1990a; AMA 1991a) examined the cancer mortality within a 50-mile radius around several nuclear facilities including Anderson and Roane counties. No excess cancer mortality was observed in the population living in the exposed counties when compared to the United States white male population, nor when compared to the population of the control counties (Blount,

Bradley, Coffee, Jefferson, Hamblen, TN, and Henderson, NC), nor when time trends were assessed.

The Tennessee Cancer Reporting System (OR DHE 1992a) of the Tennessee Department of Health and Environment also evaluated the cancer incidence and cancer mortality rates for Anderson and Roane counties and compared them with the average rates of 72 U.S. cities. Slight excesses in cancer incidence and overall mortality rates were observed, none of which were statistically significant. For Anderson County, there was a slight excess in the incidence of myelomas (observed to expected (O/E) ratio is 1.58), and cancers of the lung and bronchus (O/E = 1.21), esophagus (O/E = 2.19), and cervix uteri (O/E = 1.89). For Roane County, a slight excess in the incidence of cancers of the bone and joints (O/E = 2.50), lung and bronchus (O/E = 1.40), oral cavity and pharynx (O/E = 1.59), and stomach and small intestines (O/E = 1.27) was reported. Mortality rates were elevated for respiratory cancers (O/E = 1.24) and for cancers of the skin (O/E = 2.6) in Anderson County, and for cancers of "other lymphatic and hematopoietic tissue" (O/E = 1.45), respiratory and intrathoracic organs (O/E = 1.32), and for unspecified and "all other cancers" (O/E = 1.26) in Roane County. The only consistent excess reported for both cancer incidence and cancer mortality rates occur with cancer of the respiratory and intrathoracic organs, an excess which may be confounded by smoking.

The two population-based studies mentioned above are limited by their correlational approach and the large size of the geographic areas (counties) used.

Because of a concern for possible contamination of the population by mercury, the Tennessee Department of Health and Environment conducted a pilot study in 1984 (OR DHE 1984a). The study showed no difference in urine or hair mercury levels between individuals with potentially high mercury exposures (residence or activity in contaminated areas based on soil measurements or consumption of fish caught in the contaminated areas) compared to those with little potential exposure.[1] Mercury levels in some soils measured as high as 2,000 parts per million (ppm). Analysis of a few soil samples showed that most of the mercury in the soil, however, was inorganic thereby lowering the probability of bioaccumulation and health effects. Examination of the long-term effects of exposure to mercury and other chemicals continues.

**Workers: Radiation.** Between 1943 and 1985, there were 118,588 male and female individuals of all races who were ever employed in any of the Oak Ridge facilities. These included the Oak Ridge National Laboratory for nuclear research (also called the X-10 facility), Y-12 plant under management of the Tennessee-Eastman Corporation (1943 to 1947) which produced enriched uranium by the electromagnetic separation process, Y-12 under management of Union Carbide (1948 to 1984) which fabricated and certified nuclear weapons parts, and K-25 (Oak Ridge Gaseous Diffusion Plant) which produced enriched uranium through the gaseous process. Analyses at the Oak Ridge facilities have been carried out mostly for white males, and for specific cohorts taking into consideration time-related exposure risks. All mortality rates were compared to that of United States white males unless otherwise specified.

*Oak Ridge National Laboratory.* An excess of leukemia deaths (standard mortality ratio (SMR)) = 1.48; 95 percent Confidence Interval (CI) = 0.31-4.38) among 8,375 white male Oak Ridge National Laboratory workers employed between January 1, 1943, and December 31, 1972, was reported by Checkoway et al., (1985). The study excluded workers known to have worked at other nuclear facilities. Data from film badges used since 1951 provided an assessment of external penetrating radiation exposure. An elevated SMR was also reported for prostate cancer and Hodgkin's disease. No dose response, however, was observed for prostate cancer and Hodgkin's disease, and the numbers were too small to be statistically meaningful. The excess leukemia deaths reported in this study occurred mostly among maintenance workers and engineers who had worked for more than 10 years, suggesting a possible excess attributed to exposures other than radiation. Maintenance workers are exposed to a number of solvents, metals, and welding fumes. No attempt was made in this

1. Approximately 200,000 to 470,000 pounds of mercury were discharged into the East Fork Poplar Creek located near the Y-12 facility between 1953 and 1977. Discharges of about 2 ounces per day continued until 1983. These discharges were the result of routine releases from the New Hope Pond, a settling pond for the Y-12 facility.

analysis to control for confounders such as smoking and socioeconomic status.

The excess of leukemia deaths reported by Checkoway et al. (BJIM 1985a) was confirmed by Wing (AMA 1991a; AJIM 1993a) when the cohort of white males (n = 8,318) was followed through 1984 (SMR = 1.63; 95 percent CI = 1.08-2.35 for all workers; SMR = 2.23; 95 percent CI = 1.27-3.62 for workers monitored for internal contamination). An estimated percentage increase for leukemia rose from 6.38 percent for an exposure lag of 0 years to 9.15 percent with a 10-year lag. Of the 30 leukemia deaths in the cohort, 2 (0.7 expected) occurred in the radioisotope group, 2 (0.5 expected) occurred in the chemical operations group, and 5 (2.3 expected) occurred in the engineering research and development group.

An increase of 2.68 percent in deaths from "all causes" and 4.94 percent for "all cancers" with every 10 million Sieverts (1 rem) of cumulative dose exposure with a 20-year exposure lag was also reported by Wing (AMA 1991a;AJIM 1993a). Adjustments for confounders such job category, socioeconomic status, World War II employment, and exposure to beryllium, lead, and mercury had little or no effect on the excess risk observed. Risk estimates between cumulative exposure to low levels of external penetrating ionizing radiation and "all cause" mortality were shown to be several times the risk estimates obtained from the Japanese A-bomb survivor data for low-level radiation. This excess increased with increasing dose regardless of exposure lag time, and was stronger for exposures that occurred 20 years in the past. The excess deaths due to ill-defined causes (SMR = 2.34; 95 percent CI =1 .76-3.05 for all workers; SMR = 2.89; 95 percent CI = 1.93-4.14 for workers monitored for internal contamination) was also statistically significant. These increases remained consistent regardless of whether confounders (active work, pay code, cohort, and continuous or categorical age) were considered. Deaths from lung cancer increased 5 percent for every 10 million Sieverts (1 rem) of exposure (AMA 1991a; AJIM 1993a).

The excess in cancer deaths was associated with working in radioisotope production and chemical operations but not with work in physics, engineering, or unknown job categories. Cancer mortality was also associated with exposure to beryllium, lead, and mercury. Control of these chemicals, as well as the job exposure variable in a Poisson regression model, did not significantly affect the initial dose-response relationship observed between external low-level radiation and leukemia risks.

*Y-12 Plant.* Internal radiation exposure by inhalation of uranium compounds was the major concern for workers at the Y-12 Plant (Y-12) under Union Carbide management employed between 1947 and 1969 (n = 4,988) and followed to 1973. An elevated but not statistically significant SMR for cancer of the brain (SMR = 1.97 with 7 observed and 3.56 expected; 95 percent CI = 0.79-4.06) was reported in this cohort when compared to U.S. white males (Polednak 1980a).

The effect of alpha (internal) and gamma (external) radiation was reported by Checkoway (AJE 1988a). The cohort was restricted to 6,781 white males employed for at least 30 days and who worked between May 4, 1947, and December 12, 1974, at the Y-12 facility. Employees who worked at another nuclear facility and any worker employed prior to 1947 were excluded from the analyses (a major shift from uranium enrichment to fabrication of weapons' parts and research and development for separation of isotopes of other compounds occurred in 1947). Exposure data were available from film badges and urinalyses. Urinalysis data were converted to estimates of lung dose equivalents through the use of metabolic models. Observed mortality rates were compared to those from the U.S. white male population and to that of Tennessee white males. An excess of lung cancer mortality was observed in this cohort (SMR = 1.36; 95 percent CI = 1.09-1.67 when compared to the U.S. white male rates; SMR = 1.18; 95 percent CI = 0.95-1.45 when compared to rates from Tennessee white males). A dose-response effect appeared related to the alpha (internal) and gamma (external) radiation with the most pronounced effect observed for gamma radiation among workers exposed to 5 rems of alpha radiation. At zero-year latency assumption, the dose-response was very pronounced for workers with both 5 rems or more of alpha and gamma radiation (Rate Ratio (RR) = 4.60; 95 percent CI = 0.91-23.4). The effect was weaker when a latency of 10 years was considered (RR = 3.05; 95 percent; CI = 0.37-24.83), suggesting

that the effect may not be related to radiation. However, the estimates were based on a small number of cases (3 deaths at zero-year latency and 1 death at 10 ten-year latency) and consequently lack statistical precision. The period of observation would need to be extended for the study to have sufficient power to detect a moderate effect. Checkoway (AJE 1988a) also reported an excess of brain and central nervous cancers in this cohort (SMR = 1.80; 95 percent CI = 0.98-3.02 when compared to rates of U.S. white males; SMR = 1.42; 95 percent CI = 0.78-2.38 when compared to rates of Tennessee white males) but no dose response relationship was observed.

Polednak also reported on the mortality experience of white male workers employed at the Y-12 facility while under Tennessee-Eastman Corporation management between 1943 and 1947 (Poladnak 1980a). These workers (n = 4,008) were followed through 1973. The cohort excluded workers who continued employment after the shift in 1947 and those who worked for any other ORR facility. Exposure to external penetrating and internal radiation from uranium dusts was of concern for the Tennessee-Eastman Corporation workers. Compared to U.S. white males, the SMRs for white Tennessee-Eastman Corporation males who worked 1 year or longer was elevated for cancer of the testis (1.92), benign neoplasms (1.45), all diseases of the bones and organs of movement (3.22; 4 of the 6 deaths were due to rheumatoid arthritis), and "symptoms, senility, and ill-defined conditions" (1.77). Although the investigator reported that the 95 percent confidence estimates were calculated, none were presented in the tables.

An elevated risk for brain cancer was reported among 4,988 white males (Pedant 1980a) employed between 1947 and 1969 (Y12 workers under Union Carbide) but the excess was not statistically significant (SMR = 1.97; 95 percent CI = 0.79-4.06).

A follow-up through 1974 of all 18,869 workers employed at the Y-12 facility while under the TEC management between 1943 and 1947 was reported by Pedant and Frome (JOM 1981a). The workers included those exposed to internal ("alpha"), external ("beta") radiation through the inhalation of uranium dusts, electrical workers who performed maintenance in the exposed areas, and other non-exposed workers. Elevated but not statistically significant SMRs were observed in this cohort for mental, psychoneurotic, personality disorders (SMR = 1.36), diseases of the bones and organs of movement (SMR = 1.22), and symptoms, senility, and ill-defined conditions (SMR = 2.80). No elevated SMRs were observed for cancer of the bones and for leukemia. The crude SMR for lung cancer was 1.09 (95 percent CI = 0.97-1.22) but when adjusted for incomplete retrieval of death certificates, the SMR was significant (SMR = 1.22; 95 percent CI = 1.11-1.36). Cancer of the lung was greater among workers employed for 1 year or more compared to workers employed less than 1 year, and was more pronounced in workers hired at the age of 45 or older (odds ratio = 1.51; 95 percent CI = 1.01-2.31). Of the workers employed after the age of 44, the SMR for lung cancer was greater for electrical workers (SMR = 1.55) confirming the excess observed in the earlier analysis, for alpha chemistry workers (SMR = 3.02), and for beta process workers (SMR = 1.51).

*Combined Oak Ridge National Laboratory Facilities.* Frome reported on the mortality experience of World War II workers employed at three ORR facilities between 1943 and 1947 using poisson regression analyses to control for potential confounders (such as facility TEC, K-25, X-10, or multiple), socioeconomic status using pay code (hourly, monthly), length of employment, period of follow-up, and birth earlier 1990a). The cohort included only white males who worked at ORR at least 30 days between the start of the operation and the end of the study (December 31, 1947), and at no other time after that date. The regression analyses confirmed the significantly elevated standard mortality ratios observed for deaths from tuberculosis (SMR = 1.37), from mental, psychoneurotic, and personality disorders (SMR = 1.60), and symptoms of senility, ill-defined conditions (SMR = 3.05) reported by Polednak (1980a). No deaths were associated with exposure to radiation, however. The regression analysis showed a significant association with socioeconomic status as measured by job skill.

Carpenter investigated the earlier reports of an association between the excess number of brain cancers and employment at the Oak Ridge National Laboratory and the Y-12 Plant in a case-control study among workers employed between 1943 and 1977 (AJIM

1988a). Cases consisted of 72 white males and 17 white females. Four controls were selected for each case and matched on age, sex, cohort, year of birth, and year of hire. No statistically significant association between the use of 26 chemicals evaluated and an increased risk of brain cancer was observed. The chemicals evaluated included those encountered in welding fumes, beryllium, mercury, 4,4'-methylene bis 2-chloroaniline or MOCA, cutting oils, thorium, methylene chloride, and other solvents. However, the excess brain cancer was observed among individuals employed for more than 20 years (odds ratio = 7.0; 95 percent Confidence Interval = 1.2-41.1; cases = 9). Analyses of these cases and controls with respect to internal and external radiation exposures revealed no association between radiation exposures and development of brain cancer (JOM 1987a). However, analysis of 82 cases with complete medical records revealed an excess risk of brain cancer with a history of epilepsy (odds ratio = 5.7; 95 percent CI = 1.0-32.1) as recorded in the medical records for pre-employment and health status follow-up (AJPH 1987a). Brain cancer of glial origin (4 cases and 0 controls) was strongly associated with a history of epilepsy.

**Combined Nuclear Sites.** ORR workers were also included in a combined analysis of Hanford Site, ORR, and Rocky Flats Plant (now known as Rocky Flats Environmental Technology Site) workers (RR 1989a). White male workers employed at one of the three facilities for at least 6 months and who were monitored for external radiation were included in the study. Analyses were based on the same vital status and cause of death information previously reported. Deaths were considered through 1981 for Hanford, through 1977 for ORR, and through 1979 for Rocky Flats Plant. Hanford contributed 23,704 workers, ORR contributed 6,332 workers, and Rocky Flats Plant contributed 5,897 workers. External radiation doses were obtained from the dosimeters worn by these workers. A check for possible overlap of the Hanford and Rocky Flats Plant cohorts identified 78 workers who qualified in both study populations. These workers were included in the cohort of the facility where they first met eligibility and the dose accumulated at the second facility was not included. These analyses provide no evidence of a correlation between radiation exposure and mortality from all cancer or from leukemia and no evidence of chronic low dose exposure with any form of cancer mortality at ORR. Multiple myeloma was the only cancer found to exhibit a statistically significant correlation with radiation exposure in this multi-site analysis. However, all cases were contributed by the Hanford cohort (i.e., none was from ORR).

**Workers: Chemicals and Metals.** Only a few studies have examined the mortality of ORR workers exposed to other chemicals or metals. Polednak reported elevated mortality rates for white male workers exposed to phosgene while employed at Y-12 between 1943 and 1947 and followed through 1974 (ER 1980a). The SMR for symptoms, senility, and ill-defined conditions was 4.02 (95 percent CI = 1.61-8.28) compared to the United States white males. The SMR, however, was also elevated among workers not exposed to phosgene (SMR = 3.23; 95 percent CI = 2.62-3.97). Although not statistically significant, the analysis shows an elevated SMR for all infective and parasitic disease (SMR = 1.22; 95 percent CI = 0.4-2.84) among workers with low to moderate phosgene exposure, and which was not observed among workers not exposed to phosgene (SMR = 0.80; 95 percent CI = 0.62-1.04). The excess was due mostly to tuberculosis among exposed workers who had no prior history of tuberculosis. Among workers highly exposed to phosgene, an elevated but not statistically significant SMR for external causes of death (accidents) was also reported (SMR = 1.62; 95 percent CI = 0.52-3.77). This designation (external causes of death) includes acute chemical poisoning and at least one of the four deaths is known to have resulted from phosgene poisoning. The investigator expresses concern about one death attributed to paranoid schizophrenia since dementia precox (schizophrenia) associated with phosgene exposure was previously reported in the literature. With only 106 heavily exposed workers, the numbers are too small to identify any trends in mortality. The results of this study also highlights the problem when analyses focus only on mortality and not morbidity.

Cragle reported on the mortality experience of 2,133 Y-12 workers exposed to elemental mercury vapors used in the lithium isotope separation process (JOM 1984a). Exposure for these workers was documented through urinalysis measurements. Another 270 workers were employed in the same departments as those who were monitored and therefore were probably exposed. Finally, 3,530 workers were never

exposed. The mortality of all groups was compared to the mortality experience of U.S. white males. No statistically significant excess mortality was observed for workers exposed to mercury. The excess mortality observed for cancer of the brain and the lung was observed for all three groups and cannot be attributed to mercury exposure. Why the exposed and nonexposed were not compared using Poisson regression model or a contingency table analysis is not known but may have shed some light on mercury-specific effects. The investigators do point out, however, that mercury may exert its effects more on morbidity than on mortality.

Cragle reported on the mortality experience of the workers at the Oak Ridge Gaseous Diffusion Plant (IARC 1984a). Within this group, 800 white males were exposed to nickel powder and 7,500 workers were never exposed to nickel or the "barrier" material. Deaths in the exposed and nonexposed were compared to the mortality experience of U.S. white males. Statistically significant SMRs were observed for symptoms, senility, and ill-defined causes for both exposed (SMR = 5.93; 95 percent CI = 2.96-10.61) and nonexposed (SMR = 3.25; 95 percent CI = 2.54-4.10) workers and consequently cannot be attributed to nickel exposures. Elevated but not statistically significant SMRs were observed for cancers of the buccal cavity, liver, pancreas, and skin for the exposed workers and but not for the unexposed workers. When direct adjustments were made, all SMRs were lower than expected but the SMRs were higher in the exposed group for cancers of the buccal cavity, liver, and pancreas.

### E.4.5 Pantex Plant

**Surrounding Communities.** Incidence data from the residents of the southwestern quadrant of Carson County (zip code area 79068) nearest Pantex, which was collected between 1980 and 1990, were compared with age-, gender-, and race-specific cancer incidence in five Public Health Regions of Texas that had complete cancer reporting since 1976. This study was carried out by the Texas Department of Health (PX DOH 1992a; PX DOH 1992). The Standardized Incidence Rate for the overall cancer incidence in the Carson County area of interest was 0.84 for males (72 cancers were reported; 85.75 were expected) and 0.88 for females (63 cancers were reported; 71.96 were expected). The only cancers with elevated but statistically nonsignificant Standardized Incidence Rates were cancer of the brain (SIR = 1.82; 95 percent CI = 0.22-6.57 in females with 2 cases observed and 1.1 expected) and leukemia (SIR = 1.32; 95 percent CI = 0.36-3.37 in males with 4 cases observed and 3.04 expected; SIR = 2.11; 95 percent CI = 0.69-4.92 in females with 5 cases observed and 2.37 expected). The wide confidence intervals indicating a decrease in precision can be explained by the small number of cases.

Mortality data were obtained from the Bureau of Vital Statistics and consisted of all who died of cancer between 1980 and 1991 in the zip code of interest. The comparison group for the mortality study consisted of age-, gender-, and race-specific rates for Texas during the years 1981-1989. The results for the mortality study were similar to those observed for the incidence study, with no significant increases in cancer mortality identified.

**Workers.** Acquavella compared the mortality experience of Pantex workers employed between 1951 and 1978 with that of U.S. white males (HP 1985a). Exposure information on workers was available from film badges, but only since 1963. Only data for white males (3,564) were reported because of the small number of females (892) and nonwhites (154). The results show a possible healthy worker effect. The Standard Mortality Ratio (SMR) for "all cause" mortality was significantly less than expected (SMR = 0.72; 95 percent CI = 0.64-0.85) with 269 observed deaths and 373.71 expected. The same was true for all the cause-specific deaths except brain cancer (SMR = 1.36; 95 percent CI = 0.37-3.47) and leukemia (SMR = 1.28; 95 percent CI = 0.35-3.27). The numbers observed (brain = 4; leukemia = 4) and the numbers expected (brain = 2.95; leukemia = 3.13) were so small, however, that the excess could be attributed to chance alone.

This study has limitations that restrict the conclusions that can be drawn. First, the comparison group (U.S. white males) does not take into consideration the healthy worker effect. A more appropriate comparison group would include nonexposed workers, or workers exposed at various radiation levels. Secondly, the cohort was followed on the average for only 14.6 years. Except for the leukemias, most cancers generally have a latency period (time between cancer initiation and diagnosis) of 20 to 40

years. The period of follow-up is inadequate to identify an excess in cancer mortality except for leukemias, and the sample size is inadequate to determine any but the largest differences.

### E.4.6 Savannah River Site

**Surrounding Communities.** The Savannah River Site, established in 1953 in Aiken, SC, produces plutonium and tritium and other nuclear materials. There are reports that millions of curies of tritium have been released over the years both in plant exhaust plumes and in ground and surface water streams (ED 1982a). Only two epidemiologic studies have been done at the Savannah River Site. They are summarized below.

In 1979, Sauer (as reported by Johnson, 1982) reported an excess of leukemia and lung cancer deaths among individuals living within a 50-mile radius of SRS compared to whites living between 50 and 99 miles away. Other excesses in mortality were observed but were statistically nonsignificant. Comparison groups in Sauer's study consisted of U.S. death rates and rates for counties more than 50 miles from SRS. More current correlation analyses of cancer incidence and deaths reveal no excess leukemia and no excess of other cancers.

The most comprehensive of the recent studies was the National Cancer Institute Study (NIH 1990a; AMA 1991a) that examined cancer mortality around nuclear facilities. Exposure was based solely on geopolitical boundaries. Barnwell County was considered the exposed county and Chester, Georgetown, and Sumter counties were considered control counties. The analyses compared the mortality experience in exposed counties with the mortality experience of nonexposed counties and with the mortality experience of U.S. white males. In addition, the mortality experience in the exposed counties occurring before the facility was built was compared with the mortality experience in the same counties after the facility was built. No excess cancer mortality was observed in the population surrounding any facility when compared to the control counties, the U.S. rates or when the time trends were assessed.

Other community studies are being planned. A tumor registry has been in operation for a few years in South Carolina and Georgia, which covers the area around the site. Emory University investigators are currently analyzing data from the Georgia side of the plant while investigators at the University of South Carolina are analyzing data on the South Carolina side.

**Workers.** Evidence of an excess number of leukemia deaths has been reported in hourly workers at the Savannah River Plant (AJIM 1988a). Retrospective and prospective epidemiologic studies are being planned as part of a survey of plutonium workers at four Department of Energy facilities (Los Alamos National Laboratory, Mound Plant, Rocky Flats Plant, and SRS).

# APPENDIX F

# Appendix F

# APPENDIX F: FACILITY ACCIDENTS

## F.1 EVALUATION METHODOLOGIES AND ASSUMPTIONS

### F.1.1 Introduction

The potential for facility accidents and the magnitudes of their consequences are important factors in the evaluation of No Action and tritium supply technologies and recycling facilities addressed in this Programmatic Environmental Impact Statement (PEIS). The health risk issues are twofold and consider:

- Whether potential accidents for any tritium supply technologies or recycling facility pose unacceptable health risks to workers or the general public; and

- Whether alternative locations for tritium supply technologies and recycling facilities can provide lesser public or worker health risks. These lesser risks may arise either from a greater isolation of the site from the public, or from a reduced frequency of such external accident initiators as seismic events, aircraft crashes, and other initiating events that are external to the facility.

Public comments received during the scoping process clearly indicated the public concern with facility safety and consequent health risks, and the need to address these concerns in the decisionmaking process.

### F.1.2 Safety Design Process

The tritium supply and recycling facilities would be designed to comply with current Federal, state, and local laws, Department of Energy (DOE) orders, and industrial codes and standards. This would provide a plant that is highly resistant to the effects of natural phenomena, including earthquake, flood, tornado, and high wind, as well as credible events as appropriate to the site, such as fire and explosions, and man-made threats to its continuing structural integrity for containing hazardous materials. The facilities would be designed to maintain their continuing structural integrity in the event of any credible accident or event, including an aircraft crash, if credible at these sites.

The design process for the facilities would comply with the requirements for safety analysis and evaluation in DOE Orders 4700.1 *Project Management System* and 5480.23 *Nuclear Safety Analysis Reports*. These require that the safety assessment be an integral part of the design process to ensure compliance with all DOE safety criteria by the time that the facilities are constructed and in operation.

The safety analysis process begins early in conceptual design with identification of hazards having the potential to produce unacceptable safety consequences to workers or the public. The Preliminary Hazards Assessment determines whether the operations that take place in the facility represent enough of a risk to warrant a safety analysis report. As the design develops, failure mode and affects analyses are performed to identify events that have the potential to release hazardous and/or radioactive material. The kinds of events considered include equipment failure, spills, human error, fire and explosions, criticality, earthquake, electrical storms, tornado, flood, and aircraft crash. These postulated events become focal points for design changes or improvements to prevent unacceptable accidents. These analyses continue as the design progresses to assess the need for safety equipment and to assess the performance of this equipment in accident mitigation. Eventually, the safety analyses are formally documented in a safety analysis report.

A detailed comprehensive preliminary safety analysis report is issued upon completion of preliminary design and provides a broad assessment of the range of design basis accident scenarios and the performance of equipment provided in the facility specifically for accident consequence mitigation. The safety analysis report continues to be developed during detailed design. The safety review of the safety analysis report is completed and safety issues

resolved before initiation of construction of the facility. Final approval of the preliminary safety analysis report is required before construction can commence on the new facility. A *Final Safety Analysis Report* is also produced that includes documentation of safety-related design changes during construction and the impact of those changes on the safety assessment. It also includes the results of any safety-related research and development that has been performed to support the safety assessment of the facility. Final approval of the *Final Safety Analysis Report* is required before the facility is allowed to commence operation.

### F.1.3 Analysis Methodology

#### F.1.3.1 *Introduction*

The GENII computer code was used to estimate the consequences of all tritium supply and recycling facilities design basis accidents. For beyond design-basis accidents at tritium production facilities, which include reactors, accelerators, and support facilities, the MACCS computer code was used.

A discussion of the GENII code is provided in appendix E. A discussion of the MACCS computer code is provided in section F.1.3.2. A detailed description of the model is available in a 3-volume report: *MELCOR Accident Consequence Code System (MACCS)* (NUREG/CR-4691 SAND 86-1562).

#### F.1.3.2 *MELCOR Accident Consequence Code System Overview*

The MACCS computer code models the offsite consequences of an accident that releases a plume of radioactive materials to the atmosphere. Should such an accidental release occur, the radioactive gases and aerosols in the plume would be transported by the prevailing wind while dispersing in the atmosphere. The environment would be contaminated by radioactive materials deposited from the plume and the population would be exposed to radiation. An estimation of the range and probability of the health effects induced by the radiation exposures not avoided by protective actions and the economic costs and losses that would result from the contamination of the environment are the objectives of a MACCS calculation.

There are two fundamental aspects of the organization of MACCS which are basic to its understanding: the time scale after the accident is divided into various "phases" and the region surrounding the reactor is divided into a polar-coordinate grid.

The time scale after the accident is divided into three phases: emergency phase, intermediate phase, and long-term phase. The emergency phase begins immediately after the accident and could last up to seven days following the accident. In this period, the exposure of population to both radioactive clouds and contaminated ground is modeled. Various protective measures can be specified for this phase, including evacuation, sheltering, and dose-dependent relocation.

The intermediate phase can be used to represent a period in which evaluations are performed and decisions are made regarding the type of protective actions which need to be taken. In this period, the radioactive clouds are assumed to be gone and the only exposure pathways are those from the contaminated ground. The protective measure which can be taken during this period is temporary relocation.

The long-term phase represents all time subsequent to the intermediate phase. The only exposure pathways considered here are those resulting from the contaminated ground. A variety of protective measures can be taken in the long-term phase in order to reduce doses to acceptable levels: decontamination, interdiction, and condemnation of property.

The spatial grid used to represent the region is centered on the facility itself. The user specifies the number of radial divisions as well as their endpoint distances. Up to 35 of these divisions may be defined, extending out to a maximum distance of 6,200 miles (9,999 kilometers). The angular divisions used to define the spatial grid correspond to the 16 directions of the compass.

The emergency phase calculations utilizing dose-response models for early fatality and early injury are performed on a finer grid than the calculations of the intermediate and long-term phases. For this phase, the 16 compass sectors are divided into 3, 5, or 7 user-specified subdivisions in the calculations.

The population latent cancer fatality estimate equals $5.0 \times 10^{-4}$ times the dose in person-rem. The average individual risk of fatal cancer is obtained by taking the sum of the risk values in all sectors at the site boundary and dividing it by the number of sectors. Therefore, this result is not directly comparable to the maximum offsite individual dose estimate. The risk value for each sector is equivalent to the dose in rem times $5.0 \times 10^{-4}$ when the maximum offsite dose estimate is less than 20 rem or $1.0 \times 10^{-3}$ times the dose in rem when the dose is equal to or greater than 20 rem.

#### F.1.3.3 *Application to Tritium Production*

For the analysis of high consequence accidents at tritium supply facilities, the MACCS calculations used the source term data presented in section F.2.1 and modeled the dispersion and deposition of radionuclides released from the reactor or accelerator containments to the atmosphere with a straight-line Gaussian plume. Plume rise and dry and wet deposition were taken into consideration. One year of hourly onsite meteorological data and a weather bin sampling technique were used to represent the dispersion process according to each site's characteristic weather. Downwind concentrations of radionuclides up to a distance of 50 miles (80 kilometers) were calculated for each of 16 directional sectors around the reactor or accelerator.

Radiation doses to an offsite population were calculated in the dosimetry models using the concentrations of radionuclides obtained from the dispersion models. Dose conversion factors were used to convert the radionuclide concentrations to organ dose equivalents and whole-body effective dose equivalents. Exposure pathways considered in the MACCS for calculating doses received during the period following an accident were direct radiation from the passing plume and from radioactive material deposited on the ground, inhalation from the plume, deposition on skin, and inhalation of resuspended ground contamination. Long-term exposure pathways and liquid exposure pathways were not considered. No credit was taken for short-term actions such as evacuation, sheltering, and relocation.

## F.2 Tritium Supply and Recycling Bounding Accidents

The tritium supply facility can be configured as a reactor or as an accelerator. The reactor configuration includes the reactor, reactor fuel/target fabrication facilities, and target extraction facilities. The Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), and Advanced Light Water Reactor (ALWR) are candidate reactor technologies for tritium supply. Four ALWR configurations; the AP600, Simplified Boiling Water Reactor, Advanced Boiling Water Reactor, and CE System 80+; are under consideration for the ALWR tritium supply technology. The candidate ALWR configurations have been classified into two groups, Large ALWRs and Small ALWRs. The Advanced Boiling Water Reactor and CE System 80+ configurations are designated Large ALWRs and the AP600 and Simplified Boiling Water Reactor configurations are designated Small ALWRs. The Accelerator Production of Tritium (APT) facility configuration is associated with the linear accelerator and target areas of the facility. Two target designs are under consideration, the helium-3 target system and the spallation-induced lithium conversion target system. For the helium-3 target design, tritium would be continuously removed from the target and packaged without any additional target processing. For the spallation-induced lithium conversion target design, production targets will be processed at a tritium recycling facility collocated with the APT. The tritium recycling facility design and operation is similar for all reactor technologies and the spallation induced lithium conversion target system.

### F.2.1 Tritium Supply Facility High Consequence Accidents

High consequence accidents for candidate tritium supply technologies and recycling facilities at five potential sites, (Idaho National Engineering Laboratory (INEL), Nevada Test Site (NTS), Oak Ridge Reservation (ORR), Pantex Plant (Pantex), and Savannah River Site (SRS)), have been evaluated using the MACCS computer code. The MACCS computer code is described in section F.1.3.3. The report, *MELCOR Accident Consequence Code System*, presents additional details on the computer code.

### F.2.1.1 *Heavy Water Reactor*

**Analysis.** Previous studies performed for the HWR developed a spectrum of severe accidents and their respective source terms (DOE 1992r). The release frequencies were in the range of $2x10^{-8}$ to $1x10^{-6}$ per reactor year. The core inventory was based on a larger reactor than the one now being evaluated for tritium supply. Design and operational details for a smaller HWR that is now under consideration are not available. In order to provide a reasonably similar basis for comparisons with other technologies, the core inventory was downsized and a release category and corresponding frequency, out of several available, was chosen to represent the consequences and risks associated with a smaller HWR at each of the five candidate sites. A set of accident sequences with a release category in which there is a reactor isolation failure with containment spray failed was postulated. The selected combination of release category and frequency is representative of accident conditions at the low frequency end of the credible range for beyond design basis accidents. Other combinations of release category and frequency were modeled and evaluated that assumed conditions that are farther beyond the design basis, have higher consequences, and a lower frequency of occurrence. The source term analyzed for the selected release category is shown in table F.2.1.1–1. This estimate was based on a detailed assessment of the accident sequence, and the failure of operator actions and safety systems challenged during the sequence to mitigate the accident consequences (DOE 1992r).

**Consequences.** The estimated consequences of the postulated HWR accident for each site are shown in table F.2.1.1–2. Figure F.2.1.1–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from an HWR severe accident exceeds the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.1–1 using the MACCS computer code.

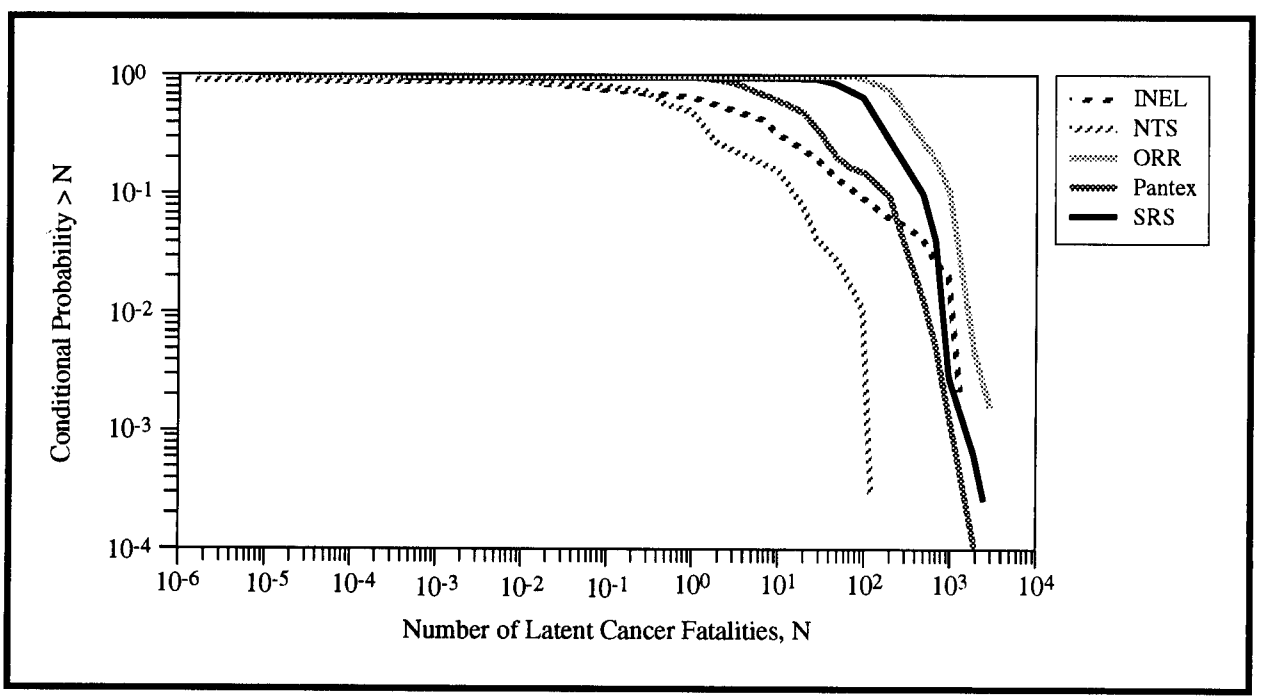



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**FIGURE F.2.1.1–1.—*Heavy Water Reactor High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.1–1.—*Source Term for Heavy Water Reactor Bounding High Consequence Accident***

| Nuclide | Core Inventory (curies) | Release Fractions Category | Nuclide | Core Inventory (curies) | Release Fractions Category |
|---|---|---|---|---|---|
| H-3 | $2.63 \times 10^{7}$ | 1.00 | I-131 | $2.10 \times 10^{7}$ | 0.03 |
| Kr-85 | $1.99 \times 10^{5}$ | 1.00 | I-132 | $3.11 \times 10^{7}$ | 0.03 |
| Kr-85m | $9.10 \times 10^{6}$ | 1.00 | I-133 | $4.85 \times 10^{7}$ | 0.03 |
| Kr-87 | $1.84 \times 10^{7}$ | 1.00 | I-134 | $5.47 \times 10^{7}$ | 0.03 |
| Kr-88 | $2.60 \times 10^{7}$ | 1.00 | I-135 | $4.51 \times 10^{7}$ | 0.03 |
| Sr-89 | $3.52 \times 10^{7}$ | 0.01 | Xe-133 | $4.75 \times 10^{7}$ | 1.00 |
| Sr-90 | $1.60 \times 10^{6}$ | 0.01 | Xe-135 | $1.17 \times 10^{7}$ | 1.00 |
| Sr-91 | $4.18 \times 10^{7}$ | 0.01 | Cs-134 | $1.42 \times 10^{6}$ | 0.03 |
| Sr-92 | $4.28 \times 10^{7}$ | 0.01 | Cs-137 | $1.67 \times 10^{6}$ | 0.03 |
| Y-90 | $1.67 \times 10^{6}$ | $5.00 \times 10^{-6}$ | Ba-139 | $4.64 \times 10^{7}$ | 0.01 |
| Y-91 | $4.28 \times 10^{7}$ | $5.00 \times 10^{-6}$ | Ba-140 | $4.56 \times 10^{7}$ | 0.01 |
| Y-92 | $4.29 \times 10^{7}$ | $5.00 \times 10^{-6}$ | La-140 | $4.69 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Y-93 | $4.63 \times 10^{7}$ | $5.00 \times 10^{-6}$ | La-141 | $4.24 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Zr-95 | $4.65 \times 10^{7}$ | $5.00 \times 10^{-6}$ | La-142 | $4.22 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Zr-97 | $4.22 \times 10^{7}$ | $5.00 \times 10^{-6}$ | Ce-141 | $4.34 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Nb-95 | $4.65 \times 10^{7}$ | $5.00 \times 10^{-6}$ | Ce-143 | $4.25 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Mo-99 | $4.32 \times 10^{7}$ | $5.00 \times 10^{-6}$ | Ce-144 | $2.90 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Tc-99m | $3.78 \times 10^{7}$ | $5.00 \times 10^{-6}$ | Pr-143 | $4.19 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Ru-103 | $2.36 \times 10^{7}$ | $5.00 \times 10^{-6}$ | Nd-147 | $1.67 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Ru-105 | $7.81 \times 10^{6}$ | $5.00 \times 10^{-6}$ | Np-239 | $1.09 \times 10^{7}$ | $5.00 \times 10^{-6}$ |
| Ru-106 | $2.09 \times 10^{6}$ | $5.00 \times 10^{-6}$ | Pu-238 | $1.26 \times 10^{4}$ | $5.00 \times 10^{-6}$ |
| Rh-105 | $7.33 \times 10^{6}$ | $5.00 \times 10^{-6}$ | Pu-239 | 160 | $5.00 \times 10^{-6}$ |
| Sb-129 | $4.99 \times 10^{6}$ | $5.00 \times 10^{-6}$ | Pu-240 | 99 | $5.00 \times 10^{-6}$ |
| Te-129 | $4.95 \times 10^{6}$ | 0.01 | Pu-241 | $4.69 \times 10^{4}$ | $5.00 \times 10^{-6}$ |
| Te-129m | $7.60 \times 10^{5}$ | 0.01 | Cm-242 | $7.43 \times 10^{3}$ | $5.00 \times 10^{-6}$ |
| Te-132 | $3.09 \times 10^{7}$ | 0.01 | Cm-244 | 134 | $5.00 \times 10^{-6}$ |

Source: DOE 1995d.

**TABLE F.2.1.1–2.—*Heavy Water Reactor High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 41 | $9.9 \times 10^{-4}$ | $1.3 \times 10^{5}$ | 63.3 | $5.0 \times 10^{-8}$ |
| NTS | 71 | $1.8 \times 10^{-3}$ | $1.3 \times 10^{4}$ | 6.4 | $5.0 \times 10^{-8}$ |
| ORR | $1.3 \times 10^{3}$ | 0.04 | $1.0 \times 10^{6}$ | 504 | $5.0 \times 10^{-8}$ |
| Pantex Plant | 426 | 0.012 | $1.3 \times 10^{5}$ | 64.4 | $5.0 \times 10^{-8}$ |
| SRS | 45 | $1.2 \times 10^{-3}$ | $4.4 \times 10^{5}$ | 222 | $5.0 \times 10^{-8}$ |

[a] All values are mean values.

### F.2.1.2 *Modular High Temperature Gas-Cooled Reactor*

**Analysis.** Previous studies performed for the MHTGR developed a spectrum of severe accidents and their respective source terms (DOE 1992r). The release frequencies were in the range of $1x10^{-9}$ to $2x10^{-6}$ per reactor year. In order to provide a reasonably similar basis for comparisons with other technologies a release category and corresponding frequency, out of several available, was chosen to represent the consequences and risks associated with an MHTGR at each of the five candidate sites. A set of accident sequences with a release category in which there is a depressurized conduction cooldown without the reactor cavity cooling system functioning was postulated. The selected combination of release category and frequency is representative of accident conditions at the low frequency end of the credible range for beyond design basis accidents. Other combinations of release category and frequency were modeled and evaluated that assumed conditions that are farther beyond the design basis, have higher consequences, and a lower frequency of occurrence. The source term analyzed for the selected release category is shown in table F.2.1.2–1.

**Consequences.** The estimated consequences of the postulated MHTGR accident for each site are shown in table F.2.1.2–2. Figure F.2.1.2–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from a MHTGR severe accident exceeds the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.2–1 using the MACCS computer code.

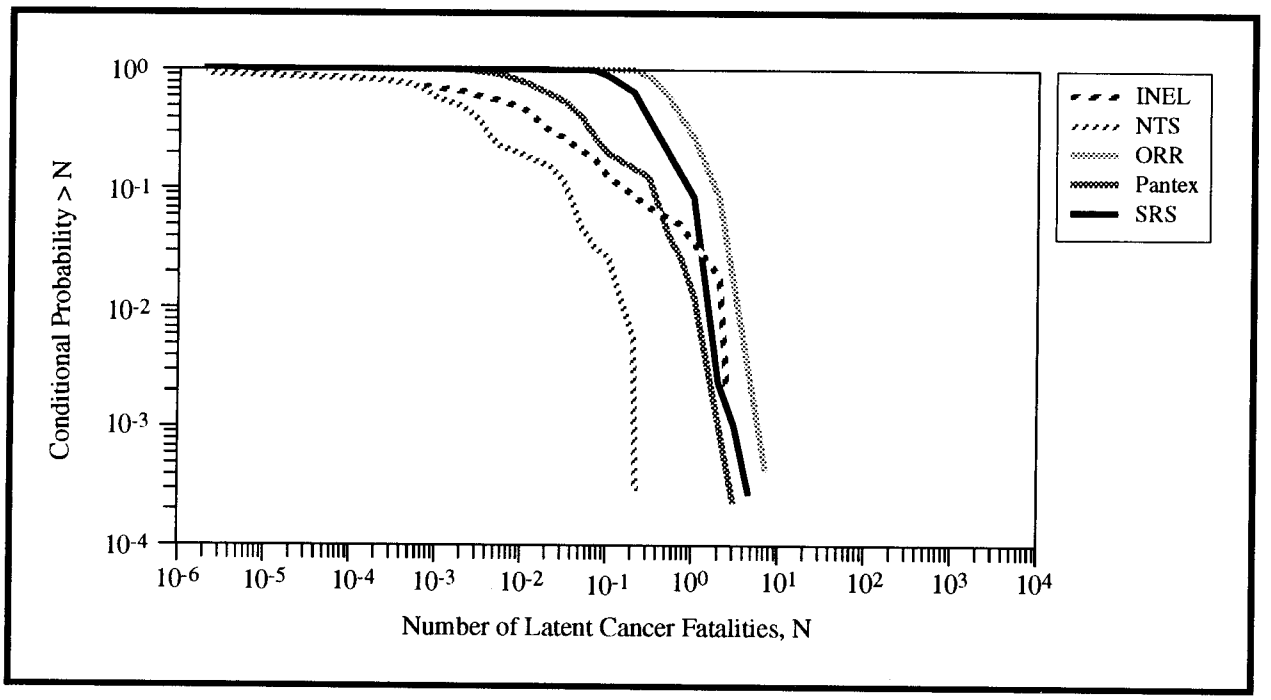


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**FIGURE F.2.1.2–1.—*Modular High Temperature Gas-Cooled Reactor High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.2–1.—*Source Term for Modular High Temperature Gas-Cooled Reactor High Consequence Accident***

| Nuclide | Release Activity (curies) | Nuclide | Release Activity (curies) |
|---|---|---|---|
| H-3 | $2.8 \times 10^{6}$ | Te-127m | 0.014 |
| Kr-85 | 0.014 | Te-129 | $8.1 \times 10^{-4}$ |
| Kr-85m | 0.017 | Te-129m | 0.037 |
| Kr-87 | $9.6 \times 10^{-3}$ | Te-131m | 0.019 |
| Kr-88 | 0.031 | Te-132 | 1.4 |
| Rb-86 | 0.028 | I-131 | 0.48 |
| Sr-89 | 490 | I-132 | 0.23 |
| Sr-90 | 29 | I-133 | 0.22 |
| Sr-91 | 6.7 | I-134 | $5.3 \times 10^{-3}$ |
| Y-90 | 18 | I-135 | 0.064 |
| Y-91 | 600 | Xe-133 | 0.20 |
| Zr-95 | 680 | Xe-135 | 0.033 |
| Zr-97 | 47 | Cs-134 | 85 |
| Nb-95 | 660 | Cs-136 | 61 |
| Mo-99 | 340 | Cs-137 | 37 |
| Tc-99m | 5.8 | Ba-140 | 450 |
| Ru-103 | 390 | La-140 | 270 |
| Ru-105 | 0.020 | Ce-141 | 620 |
| Ru-106 | 28 | Ce-143 | 160 |
| Rh-105 | 45 | Ce-144 | 230 |
| Sb-127 | 14 | Pr-143 | 540 |
| Sb-129 | $3.9 \times 10^{-6}$ | Nd-147 | 210 |
| Te-127 | 0.17 | | |

Source: DOE 1995e.

**TABLE F.2.1.2–2.—*Modular High Temperature Gas-Cooled Reactor High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 0.08 | $1.8 \times 10^{-6}$ | 226 | 0.11 | $6.0 \times 10^{-8}$ |
| NTS | 0.14 | $3.3 \times 10^{-6}$ | 22.7 | 0.01 | $6.0 \times 10^{-8}$ |
| ORR | 2.48 | $6.8 \times 10^{-5}$ | $1.9 \times 10^{3}$ | 0.92 | $6.0 \times 10^{-8}$ |
| Pantex Plant | 0.82 | $2.2 \times 10^{-5}$ | 236 | 0.12 | $6.0 \times 10^{-8}$ |
| SRS | 0.083 | $2.3 \times 10^{-6}$ | 800 | 0.40 | $6.0 \times 10^{-8}$ |

[a] All values are mean values.

### F.2.1.3 *Advanced Light Water Reactor*

**Analysis.** Previous studies performed for the ALWR developed a spectrum of severe accidents and their respective source terms (DOESNL 1995a 1995f). The studies of the four ALWR technologies were for the Advanced Boiling Water Reactor, CE System 80+, AP600, and the Simplified Boiling Water Reactor and were performed independently by their respective vendors for licensing purposes. Because they were performed independently, the modeling assumptions, techniques, and resulting source terms and consequences do not have uniform bases. Although the results are considered adequate for comparisons with other non-ALWR technologies, they are not used for comparisons among the four ALWR technologies without further analyses using uniform bases. The release frequencies for the four ALWR release categories were in the range of $5x10^{-11}$ to $2x10^{-6}$ per reactor year. In order to provide a reasonably similar basis for comparisons with other technologies, a release category and corresponding frequency, out of several available, were chosen to represent the consequences and risks associated with each ALWR technology at each of the five candidate sites. The selected combination of release category and frequency for each technology is representative of accident conditions at the low frequency end of the credible range for beyond design basis accidents. Other combinations of release category and frequency were modeled and evaluated for each ALWR technology that assumed conditions that are farther beyond the design basis, have higher consequences, and lower frequency of occurrence. The source terms for the selected release categories are shown in tables F.2.1.3.1–1 through F.2.1.3.4–1.

**Consequences.** The source terms and accident consequences for the four candidate ALWR configurations, (i.e., the Advanced Boiling Water Reactor, CE System 80+, AP600, and the Simplified Boiling Water Reactor), are presented in sections F.2.1.3.1 through F.2.1.3.4. The candidate ALWR configurations have been classified into two groups, Large ALWRs and Small ALWRs. The Advanced Boiling Water Reactor and CE System 80+ configurations are designated Large ALWRs and the AP600 and Simplified Boiling Water Reactor configurations are designated Small ALWRs.

#### F.2.1.3.1 *Advanced Boiling Water Reactor*

Table F.2.1.3.1–1 presents the source term released to the environment during the Advanced Boiling Water Reactor high consequence core failure accident. The estimated consequences for the postulated Advanced Boiling Water Reactor core failure accident for each site are shown in table F.2.1.3.1–2. Figure F.2.1.3.1–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from an Advanced Boiling Water Reactor severe accident exceed the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.3.1–1 using the MACCS computer code.

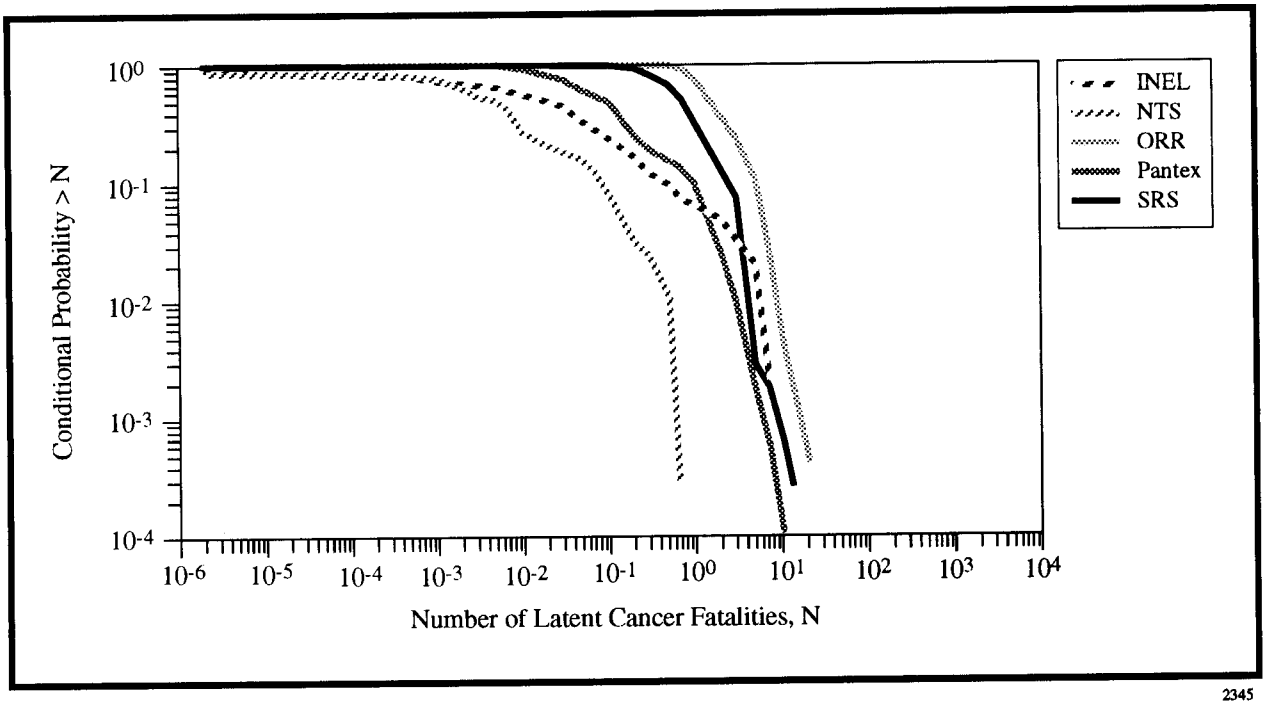


FIGURE F.2.1.3.1–1.—*Advanced Boiling Water Reactor High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.*

**TABLE F.2.1.3.1–1.—*Source Term for the Advanced Boiling Water Reactor High Consequence Accident***

| Nuclide | Core Inventory (curies) | Release Fractions | Nuclide | Core Inventory (curies) | Release Fractions |
|---|---|---|---|---|---|
| H-3 | $3.19 \times 10^{7}$ | 1.00 | I-133 | $2.17 \times 10^{8}$ | $1.50 \times 10^{-7}$ |
| Kr-85 | $1.01 \times 10^{6}$ | 1.00 | I-134 | $2.38 \times 10^{8}$ | $1.50 \times 10^{-7}$ |
| Kr-85m | $3.65 \times 10^{7}$ | 1.00 | I-135 | $2.04 \times 10^{8}$ | $1.50 \times 10^{-7}$ |
| Kr-87 | $6.65 \times 10^{7}$ | 1.00 | Xe-133 | $2.17 \times 10^{8}$ | 1.00 |
| Kr-88 | $8.97 \times 10^{7}$ | 1.00 | Xe-135 | $5.16 \times 10^{7}$ | 1.00 |
| Rb-86 | $5.62 \times 10^{4}$ | $1.30 \times 10^{-5}$ | Cs-134 | $1.69 \times 10^{7}$ | $1.30 \times 10^{-5}$ |
| I-131 | $1.04 \times 10^{8}$ | $1.50 \times 10^{-7}$ | Cs-136 | $4.54 \times 10^{6}$ | $1.30 \times 10^{-5}$ |
| I-132 | $1.52 \times 10^{8}$ | $1.50 \times 10^{-7}$ | Cs-137 | $1.01 \times 10^{7}$ | $1.30 \times 10^{-5}$ |

Source: DOE 1995f.

**TABLE F.2.1.3.1–2.—*Advanced Boiling Water Reactor High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 17.5 | $9.7 \times 10^{-5}$ | $1.4 \times 10^{3}$ | 0.67 | $2.0 \times 10^{-8}$ |
| NTS | 25.7 | $1.6 \times 10^{-4}$ | 137 | 0.07 | $2.0 \times 10^{-8}$ |
| ORR | 238 | $2.0 \times 10^{-3}$ | $5.3 \times 10^{4}$ | 26.3 | $2.0 \times 10^{-8}$ |
| Pantex Plant | 78.3 | $8.2 \times 10^{-4}$ | $5.5 \times 10^{3}$ | 2.8 | $2.0 \times 10^{-8}$ |
| SRS | 12.0 | $9.1 \times 10^{-5}$ | $1.0 \times 10^{4}$ | 5.0 | $2.0 \times 10^{-8}$ |

[a] All values are mean values.

### F.2.1.3.2 *CE System 80+ Advanced Light Water Reactor*

Table F.2.1.3.2–1 presents the source term released to the environment during the CE System 80+ ALWR high consequence core failure accident. The estimated consequences for the CE System 80+ ALWR core failure accident for each site are shown in table F.2.1.3.2–2. Figure F.2.1.3.2–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from a CE System 80+ ALWR severe accident exceed the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.3.2–1 using the MACCS computer code.

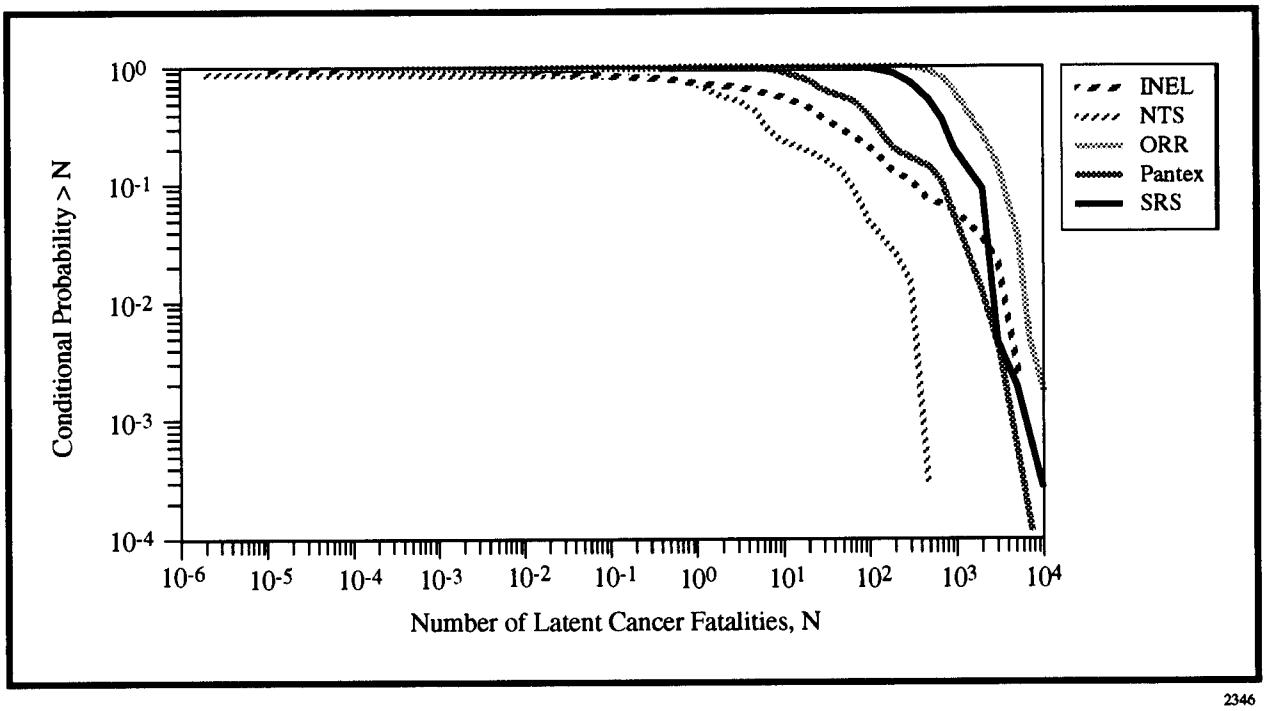


**FIGURE F.2.1.3.2–1.—*CE System 80+ Advanced Light Water Reactor High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.3.2–1.—*Source Term for CE System 80+ Advanced Light Water Reactor High Consequence Accident***

| Nuclide | Core Inventory (curies) | Release Fractions | Nuclide | Core Inventory (curies) | Release Fractions |
|---|---|---|---|---|---|
| H-3 | $3.20x10^{7}$ | 1.0 | Te-132 | $1.67x10^{8}$ | $8.30x10^{-3}$ |
| Kr-85 | $1.13x10^{6}$ | 1.0 | I-131 | $1.17x10^{8}$ | 0.024 |
| Kr-85m | $3.69x10^{7}$ | 1.0 | I-132 | $1.70x10^{8}$ | 0.024 |
| Kr-87 | $7.23x10^{7}$ | 1.0 | I-133 | $2.47x10^{8}$ | 0.024 |
| Kr-88 | $1.02x10^{8}$ | 1.0 | I-134 | $2.73x10^{8}$ | 0.024 |
| Rb-86 | $1.56x10^{5}$ | 0.016 | I-135 | $2.30x10^{8}$ | 0.024 |
| Sr-89 | $1.39x10^{8}$ | $3.20x10^{-4}$ | Xe-133 | $2.47x10^{8}$ | 1.0 |
| Sr-90 | $8.90x10^{6}$ | $3.20x10^{-4}$ | Xe-135 | $6.33x10^{7}$ | 1.0 |
| Sr-91 | $1.69x10^{8}$ | $3.20x10^{-4}$ | Cs-134 | $1.07x10^{7}$ | 0.016 |
| Sr-92 | $1.79x10^{8}$ | $3.20x10^{-4}$ | Cs-136 | $4.12x10^{6}$ | 0.016 |
| Y-90 | $9.23x10^{6}$ | $4.00x10^{-4}$ | Cs-137 | $1.08x10^{6}$ | 0.016 |
| Y-91 | $1.75x10^{8}$ | $4.00x10^{-4}$ | Ba-139 | $2.25x10^{8}$ | $2.10x10^{-5}$ |
| Y-92 | $1.79x10^{8}$ | $4.00x10^{-4}$ | Ba-140 | $2.19x10^{8}$ | $2.10x10^{-5}$ |
| Y-93 | $2.01x10^{8}$ | $4.00x10^{-4}$ | La-140 | $2.25x10^{8}$ | $4.00x10^{-4}$ |
| Zr-95 | $2.18x10^{8}$ | $4.00x10^{-4}$ | La-141 | $2.06x10^{8}$ | $4.00x10^{-4}$ |
| Zr-97 | $2.07x10^{8}$ | $4.00x10^{-4}$ | La-142 | $2.01x10^{8}$ | $4.00x10^{-4}$ |
| Nb-95 | $2.19x10^{8}$ | $4.00x10^{-4}$ | Ce-141 | $2.09x10^{8}$ | $2.00x10^{-3}$ |
| Mo-99 | $2.20x10^{8}$ | $1.70x10^{-4}$ | Ce-143 | $1.97x10^{8}$ | $2.00x10^{-3}$ |
| Tc-99m | $1.93x10^{8}$ | $1.70x10^{-4}$ | Ce-144 | $1.57x10^{8}$ | $2.00x10^{-3}$ |
| Ru-103 | $1.63x10^{8}$ | $1.70x10^{-4}$ | Pr-143 | $1.93x10^{8}$ | $4.00x10^{-4}$ |
| Ru-105 | $9.62x10^{7}$ | $1.70x10^{-4}$ | Nd-147 | $8.18x10^{7}$ | $4.00x10^{-4}$ |
| Ru-106 | $3.91x10^{7}$ | $1.70x10^{-4}$ | Np-239 | $1.78x10^{9}$ | $2.00x10^{-3}$ |
| Rh-105 | $9.00x10^{7}$ | $1.70x10^{-4}$ | Pu-238 | $1.08x10^{5}$ | $2.00x10^{-3}$ |
| Sb-127 | $1.09x10^{7}$ | $8.30x10^{-3}$ | Pu-239 | $3.38x10^{9}$ | $2.00x10^{-3}$ |
| Sb-129 | $3.49x10^{7}$ | $8.30x10^{-3}$ | Pu-240 | $4.17x10^{4}$ | $2.00x10^{-3}$ |
| Te-127 | $1.08x10^{7}$ | $8.30x10^{-3}$ | Pu-241 | $7.87x10^{6}$ | $2.00x10^{-3}$ |
| Te-127m | $1.42x10^{6}$ | $8.30x10^{-3}$ | Am-241 | $6.12x10^{3}$ | $4.00x10^{-4}$ |
| Te-129 | $3.44x10^{7}$ | $8.30x10^{-3}$ | Cm-242 | $1.36x10^{6}$ | $4.00x10^{-4}$ |
| Te-129m | $5.15x10^{6}$ | $8.30x10^{-3}$ | Cm-244 | $1.90x10^{4}$ | $4.00x10^{-4}$ |
| Te-131m | $1.63x10^{7}$ | $8.30x10^{-3}$ | | | |

Source: DOE 1993n:2.

**TABLE F.2.1.3.2–2.—*CE System 80+ Advanced Light Water Reactor High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 166 | $3.7x10^{-3}$ | $4.6x10^{5}$ | 229 | $2.0x10^{-8}$ |
| NTS | 284 | $6.7x10^{-3}$ | $4.6x10^{4}$ | 23 | $2.0x10^{-8}$ |
| ORR | $5.1x10^{3}$ | 0.13 | $3.7x10^{6}$ | $1.9x10^{3}$ | $2.0x10^{-8}$ |
| Pantex Plant | $1.7x10^{3}$ | 0.04 | $4.8x10^{5}$ | 238 | $2.0x10^{-8}$ |
| SRS | 174 | $4.6x10^{-3}$ | $1.6x10^{6}$ | 808 | $2.0x10^{-8}$ |

[a] All values are mean values.

### F.2.1.3.3 *AP600 Advanced Light Water Reactor*

Table F.2.1.3.3–1 presents the source term released to the environment during the AP600 ALWR high consequence core failure accident. The estimated consequences of the postulated AP600 ALWR core failure accident for each site are shown in table F.2.1.3.3–2. Figure F.2.1.3.3–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result when an AP600 ALWR severe accident exceeds the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.3.3–1 using the MACCS computer code.

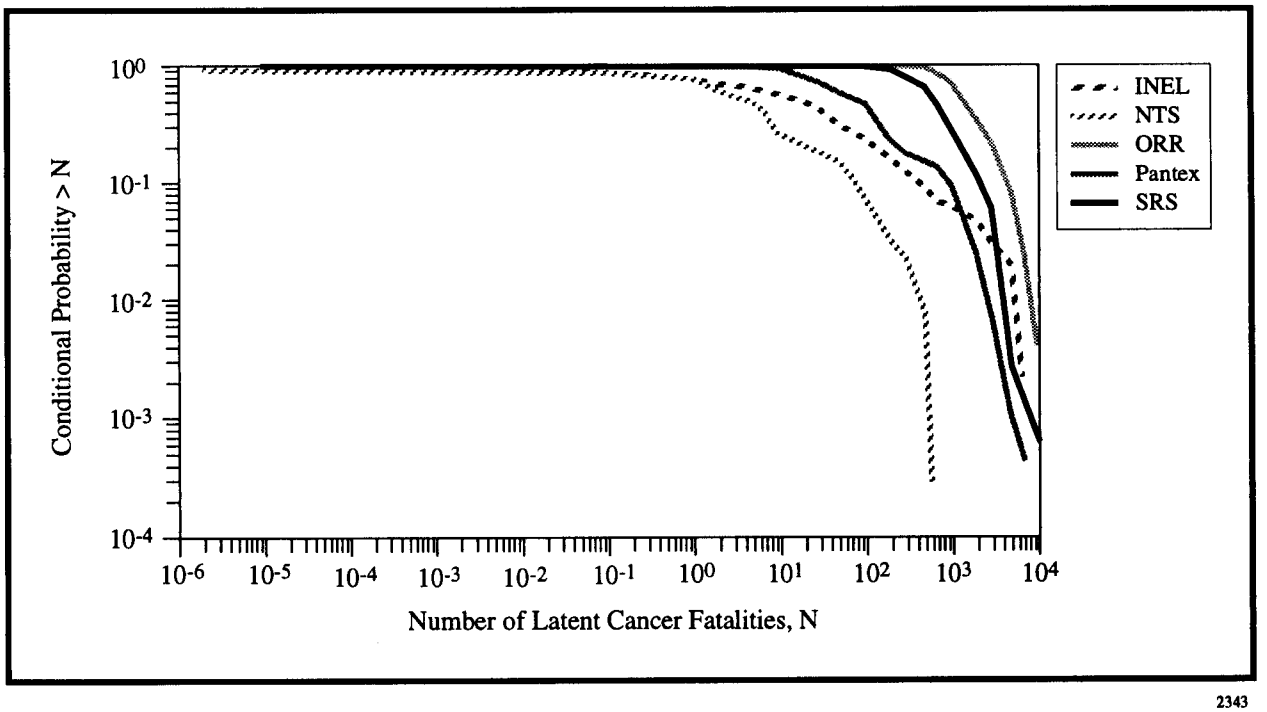


**FIGURE F.2.1.3.3–1.—*AP600 Advanced Light Water Reactor High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.3.3–1.—*Source Term for AP600 Advanced Light Water Reactor High Consequence Accident***

| Nuclide | Core Inventory (curies) | Release Fractions | Nuclide | Core Inventory (curies) | Release Fractions |
|---|---|---|---|---|---|
| H-3 | $3.20 \times 10^{7}$ | 0.34 | Te-132 | $7.90 \times 10^{7}$ | $1.10 \times 10^{-3}$ |
| Kr-85 | $5.40 \times 10^{5}$ | 0.34 | I-131 | $5.50 \times 10^{7}$ | 0.037 |
| Kr-85m | $1.40 \times 10^{7}$ | 0.34 | I-132 | $8.00 \times 10^{7}$ | 0.037 |
| Kr-87 | $2.70 \times 10^{7}$ | 0.34 | I-133 | $1.10 \times 10^{8}$ | 0.037 |
| Kr-88 | $3.80 \times 10^{7}$ | 0.34 | I-134 | $1.20 \times 10^{8}$ | 0.037 |
| Sr-89 | $5.20 \times 10^{7}$ | $6.70 \times 10^{-5}$ | I-135 | $1.00 \times 10^{8}$ | 0.037 |
| Sr-90 | $4.40 \times 10^{6}$ | $6.70 \times 10^{-5}$ | Xe-133 | $1.10 \times 10^{8}$ | 0.34 |
| Ru-103 | $8.90 \times 10^{7}$ | $1.40 \times 10^{-3}$ | Xe-135 | $3.60 \times 20^{7}$ | 0.34 |
| Ru-106 | $2.90 \times 10^{7}$ | $1.40 \times 10^{-3}$ | Cs-134 | $9.00 \times 10^{6}$ | 0.037 |
| Te-129m | $4.70 \times 10^{6}$ | $1.10 \times 10^{-3}$ | Cs-136 | $2.80 \times 10^{6}$ | 0.037 |
| Te-131m | $8.40 \times 10^{6}$ | $1.10 \times 10^{-3}$ | Cs-137 | $6.10 \times 10^{6}$ | 0.037 |

Source: DOE 1995f.

**TABLE F.2.1.3.3–2.—*AP600 Advanced Light Water Reactor High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 149 | $4.3 \times 10^{-3}$ | $5.7 \times 10^{5}$ | 282 | $2.0 \times 10^{-8}$ |
| NTS | 266 | $7.7 \times 10^{-3}$ | $5.7 \times 10^{4}$ | 28.4 | $2.0 \times 10^{-8}$ |
| ORR | $5.3 \times 10^{3}$ | 0.16 | $4.4 \times 10^{6}$ | $2.1 \times 10^{3}$ | $2.0 \times 10^{-8}$ |
| Pantex Plant | $1.7 \times 10^{3}$ | 0.05 | $5.7 \times 10^{5}$ | 283 | $2.0 \times 10^{-8}$ |
| SRS | $1.7 \times 10^{2}$ | $5.3 \times 10^{-3}$ | $2.0 \times 10^{6}$ | 984 | $2.0 \times 10^{-8}$ |

[a] All values are mean values.

### F.2.1.3.4 *Simplified Boiling Water Reactor*

Table F.2.1.3.4–1 presents the source term released to the environment during the Simplified Boiling Water Reactor high consequence core failure accident. The estimated consequences for the postulated Simplified Boiling Water Reactor core failure accident for each site are shown in table F.2.1.3.3–2. Figure F.2.1.3.4–1 present the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from a Simplified Boiling Water Reactor severe accident exceed the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.3.4–1 using the MACCS computer code.

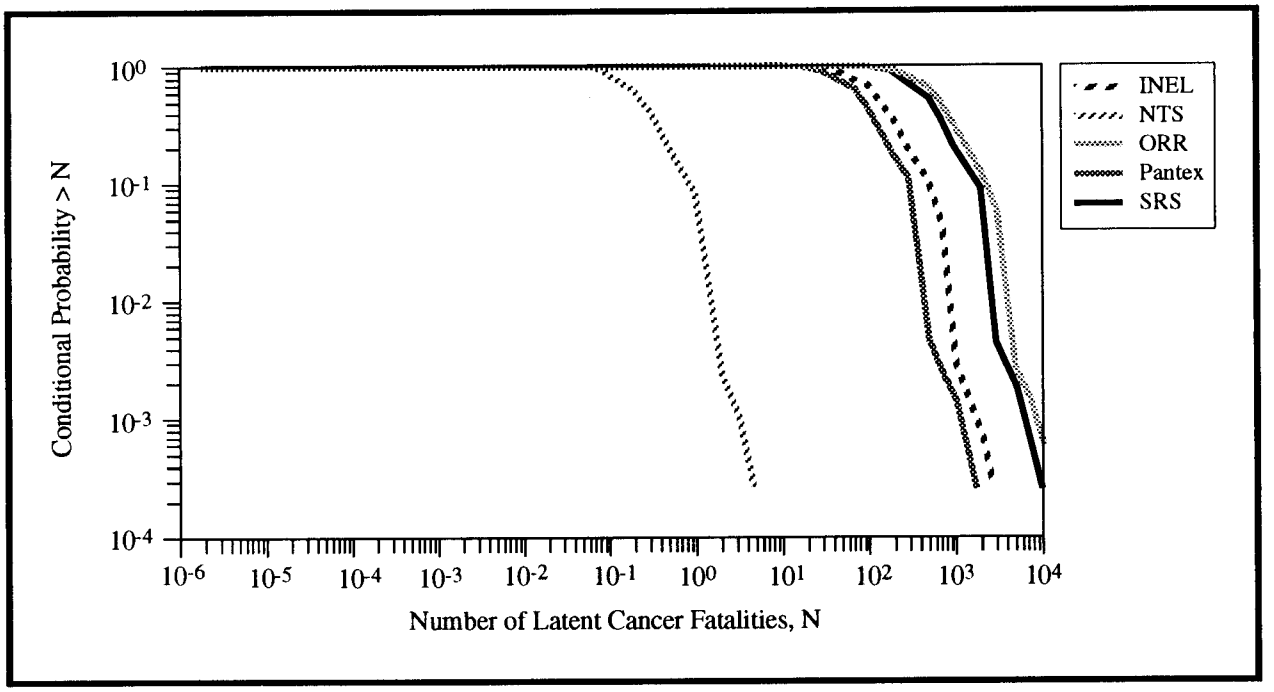


**FIGURE F.2.1.3.4–1.—*Simplified Boiling Water Reactor High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.3.4–1.—*Source Term for Simplified Boiling Water Reactor High Consequence Accident***

| Nuclide | Core Inventory (curies) | Release Fractions | Nuclide | Core Inventory (curies) | Release Fractions |
|---|---|---|---|---|---|
| H-3 | $3.19\times10^{7}$ | 1.00 | Te-131m | $7.78\times10^{6}$ | 0.0100 |
| Co-58 | $3.11\times10^{5}$ | $4.90\times10^{-5}$ | Te-132 | $7.62\times10^{7}$ | 0.0100 |
| Co-60 | $3.73\times10^{5}$ | $4.90\times10^{-5}$ | I-131 | $5.27\times10^{7}$ | $1.60\times10^{-3}$ |
| Kr-85 | $5.11\times10^{5}$ | 1.00 | I-132 | $7.73\times10^{7}$ | $1.60\times10^{-3}$ |
| Kr-85m | $1.86\times10^{7}$ | 1.00 | I-133 | $1.11\times10^{8}$ | $1.60\times10^{-3}$ |
| Kr-87 | $3.38\times10^{7}$ | 1.00 | I-134 | $1.21\times10^{8}$ | $1.60\times10^{-3}$ |
| Kr-88 | $4.57\times10^{7}$ | 1.00 | I-135 | $1.04\times10^{8}$ | $1.60\times10^{-3}$ |
| Rb-86 | $2.86\times10^{4}$ | $5.6\times10^{-3}$ | Xe-133 | $1.11\times10^{8}$ | 1.00 |
| Sr-89 | $5.65\times10^{7}$ | $1.90\times10^{-6}$ | Xe-135 | $2.63\times10^{7}$ | 1.00 |
| Sr-90 | $4.00\times10^{6}$ | $1.90\times10^{-6}$ | Cs-134 | $8.62\times10^{6}$ | $5.6\times10^{-3}$ |
| Sr-91 | $7.35\times10^{7}$ | $1.90\times10^{-6}$ | Cs-136 | $2.31\times10^{6}$ | $5.6\times10^{-3}$ |
| Sr-92 | $7.68\times10^{4}$ | $1.90\times10^{-6}$ | Cs-137 | $5.16\times10^{6}$ | $5.6\times10^{-3}$ |
| Y-90 | $4.30\times10^{6}$ | $2.80\times10^{-7}$ | Ba-139 | $1.02\times10^{8}$ | $7.9\times10^{-6}$ |
| Y-91 | $6.89\times10^{7}$ | $2.80\times10^{-7}$ | Ba-140 | $1.01\times10^{8}$ | $7.9\times10^{-6}$ |
| Y-92 | $7.70\times10^{7}$ | $2.80\times10^{-7}$ | La-140 | $1.02\times10^{8}$ | $2.80\times10^{-7}$ |
| Y-93 | $8.76\times10^{7}$ | $2.80\times10^{-7}$ | La-141 | $9.46\times10^{7}$ | $2.80\times10^{-7}$ |
| Zr-95 | $9.08\times10^{7}$ | $2.80\times10^{-7}$ | La-142 | $9.11\times10^{7}$ | $2.80\times10^{-7}$ |
| Zr-97 | $9.35\times10^{7}$ | $2.80\times10^{-7}$ | Ce-141 | $9.14\times10^{7}$ | $1.50\times10^{-6}$ |
| Nb-95 | $8.59\times10^{7}$ | $2.80\times10^{-7}$ | Ce-143 | $8.89\times10^{7}$ | $1.50\times10^{-6}$ |
| Mo-99 | $9.92\times10^{7}$ | $4.90\times10^{-5}$ | Ce-144 | $5.92\times10^{7}$ | $1.50\times10^{-6}$ |
| Tc-99m | $8.57\times10^{7}$ | $4.90\times10^{-5}$ | Pr-143 | $8.70\times10^{7}$ | $2.80\times10^{-7}$ |
| Ru-103 | $7.51\times10^{7}$ | $4.90\times10^{-5}$ | Nd-147 | $3.89\times10^{7}$ | $2.80\times10^{-7}$ |
| Ru-105 | $5.00\times10^{7}$ | $4.90\times10^{-5}$ | Np-239 | $1.16\times10^{9}$ | $1.50\times10^{-6}$ |
| Ru-106 | $2.04\times10^{7}$ | $4.90\times10^{-5}$ | Pu-238 | $8.05\times10^{4}$ | $1.50\times10^{-6}$ |
| Rh-105 | $3.73\times10^{7}$ | $4.90\times10^{-5}$ | Pu-239 | $2.04\times10^{4}$ | $1.50\times10^{-6}$ |
| Sb-127 | $4.73\times10^{6}$ | 0.0100 | Pu-240 | $2.56\times10^{4}$ | $1.50\times10^{-6}$ |
| Sb-129 | $1.65\times10^{7}$ | 0.0100 | Pu-241 | $4.41\times10^{6}$ | $1.50\times10^{-6}$ |
| Te-127 | $4.59\times10^{6}$ | 0.0100 | Am-241 | $4.46\times10^{3}$ | $2.80\times10^{-7}$ |
| Te-127m | $6.19\times10^{5}$ | 0.0100 | Cm-242 | $1.18\times10^{6}$ | $2.80\times10^{-7}$ |
| Te-129 | $1.54\times10^{7}$ | 0.0100 | Cm-244 | $6.38\times10^{4}$ | $2.80\times10^{-7}$ |
| Te-129m | $4.05\times10^{6}$ | 0.0100 | | | |

Source: DOE 1995f.

**TABLE F.2.1.3.4–2.—*Simplified Boiling Water Reactor High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 31 | $6.4\times10^{-4}$ | $7.9\times10^{4}$ | 39.6 | $1.0\times10^{-8}$ |
| NTS | 52 | $1.2\times10^{-3}$ | $8.0\times10^{3}$ | 4.0 | $1.0\times10^{-8}$ |
| ORR | 874 | 0.02 | $6.4\times10^{5}$ | 320 | $1.0\times10^{-8}$ |
| Pantex Plant | 287 | $7.6\times10^{-3}$ | $8.1\times10^{4}$ | 40.7 | $1.0\times10^{-8}$ |
| SRS | 31 | $7.8\times10^{-4}$ | $2.8\times10^{5}$ | 139 | $1.0\times10^{-8}$ |

[a] All values are mean values.

### F.2.1.4 *Accelerator Production of Tritium*

A study of the APT performed by Sandia National Laboratories, New Mexico, for DOE (SNL 1995a:8-1, 8-2) has evaluated the hazards associated with the APT accelerator and beam transport system and has judged them to be a Category 3 hazard per DOE Order 5480.23. (A Category 3 hazard has the potential for only significant, but localized onsite consequences.) The spallation-induced lithium conversion and helium-3 target systems have been judged to be a Category 2 hazard (A Category 2 hazard has the potential for significant onsite consequences, but does not have the potential for significant offsite consequences.). The helium-3 target tritium extraction has been judged a Category 3 hazard because only 15 g of tritium is expected to be contained in the helium-3 blanket and in the target extraction facility. The spallation-induced lithium conversion target tritium extraction has been judged a Category 2 hazard.

#### F.2.1.4.1 *Accelerator and Beam Transport System*

**Scenario.** The only beyond design basis event currently identified for the accelerator and beam transport system that has any significant probability involves misdirection or misfocusing of the beam. In this scenario, the beam is not terminated rapidly by the fast protection system, leading to vacuum seal failure, outright breaching of the vacuum system envelope, and/or partial melting of critical accelerator structures (SNL 1995a:8-9).

**Consequences.** The major consequence of this accident would be lost production time (SNL 1995a:8-9).

#### F.2.1.4.2 *Helium-3 Target System*

**Scenario.** The high consequence accident for the Full and Phased APT is a large break loss of coolant accident with total failure of the active emergency cooling system and loss of heat sink. A bounding source term release to the environment was determined. Table F.2.1.4.2–1 presents the source term released by the Full APT during the accident and table F.2.1.4.2–1 presents the source term released by the Phased APT during the accident. The analysis did not estimate the accident annual frequency of occurrence (SNL 1995a:8-18).

The postulated accident sequence assumed that the confinement system remained operational. The probability of the accident is in the residual risk category, but it is within the design basis of confinement (SNL 1995a:8-18) The evaluation to bound the accident frequency of occurrence assumed that the APT safety systems were designed to remain functional following a design basis earthquake or a safe shutdown earthquake with a return frequency of $1.0 \times 10^{-4}$ per year. The evaluation also assumed that the APT pressure boundary will fail but the confinement system may survive an earthquake with a return frequency of $1.0 \times 10^{-5}$ per year. Catastrophic failure of the confinement system could be expected after an earthquake with a return frequency of $1.0 \times 10^{-6}$ per year. Since the accident source term assumed that the confinement system is functional following the initiating event, the annual frequency of occurrence for the postulated accident is estimated to be in the $1.0 \times 10^{-4}$ to $1.0 \times 10^{-5}$ per year range. For the purpose of calculating the point estimate of risk for the postulated accident, the accident annual frequency of occurrence is assumed to be $1.0 \times 10^{-4}$ per year, the return frequency for the design basis earthquake.

**Consequences.** The estimated consequences of the postulated Full and Phased APT with the helium-3 target system bounding accidents for each site are shown in tables F.2.1.4.2–3 and F.2.1.4.2–4. Comparison of tables F.2.1.4.2–3 and F.2.1.4.2–4 indicates that the resultant doses and cancer risks are identical for the Full and the Phased APT beyond design basis accidents. Review of the source terms for both accidents (tables F.2.1.4.2–1 and F.2.1.4.2–2) indicates that the tritium component of the source term is identical for both accidents. Review of the MACCS computer code output data for each accident analysis indicated that the tritium component of the source term dominated the dose calculation results. The impact of the other source term isotopes on the dose calculation results was negligible. Figure F.2.1.4.2–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from an APT with the helium-3 target severe accident exceeds the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.4.2–1 using the MACCS computer code.

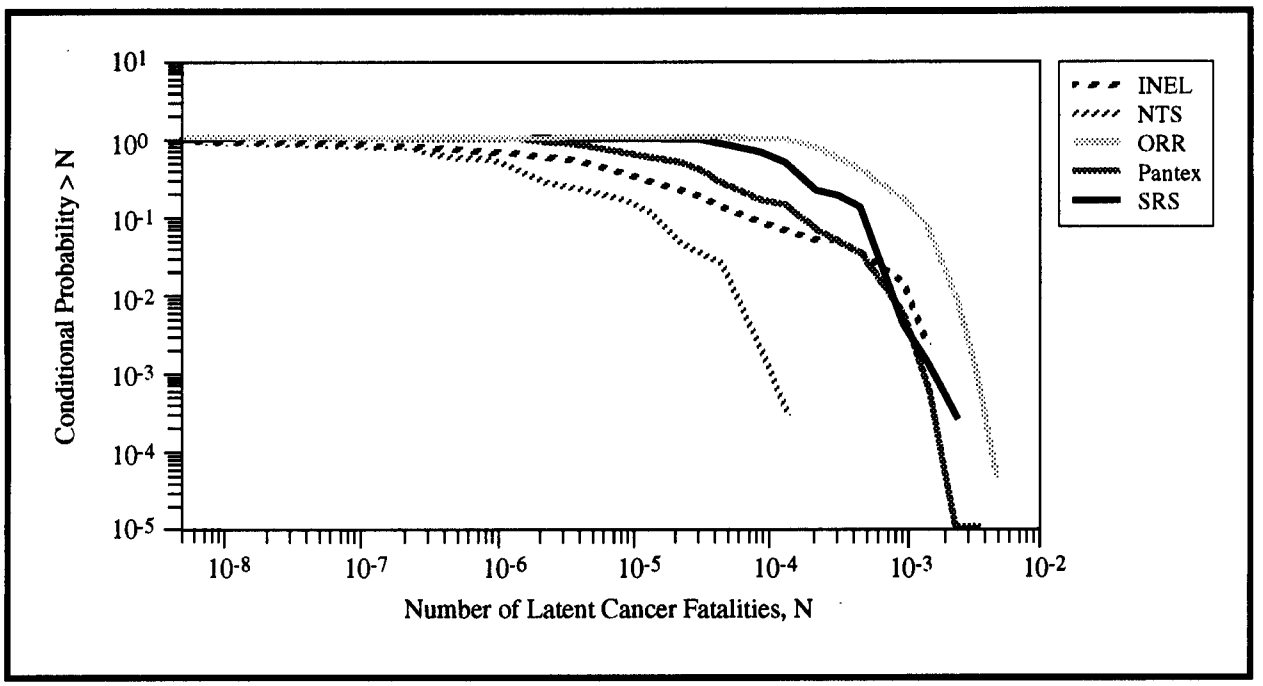


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**FIGURE F.2.1.4.2–1.**—***Full Accelerator Production of Tritium with the Helium-3 Target System High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.4.2–1.**—***Source Term for Full Accelerator Production of Tritium with Helium-3 Target System High Consequence Accident***

| Isotope | Released Activity (curies) | Isotope | Released Activity (curies) |
|---|---|---|---|
| H-3 | 1,500 | Cs-128 | 22 |
| W-185 | 14,500 | I-125 | 21 |
| W-187 | 10,600 | Ar-37 | 11 |
| W-181 | 2,840 | Cs-127 | 10 |
| W-178 | 910 | Te-121 | 9 |
| Xe-127 | 51 | I-123 | 8 |
| W-177 | 47 | Kr-79 | 7 |
| W-176 | 42 | Re-186 | 7 |
| Cs-131 | 38 | I-131 | <1 |
| Xe-125 | 29 | I-133 | <1 |
| Cs-129 | 25 | I-135 | <1 |

Source: SNL 1995a.

**TABLE F.2.1.4.2–2.—*Source Term for Phased Accelerator Production of Tritium with Helium-3 Target System High Consequence Accident***

| Isotope | Released Activity (curies) | Isotope | Released Activity (curies) |
|---|---|---|---|
| H-3 | 1,500 | Cs-128 | 11 |
| W-185 | 7,000 | I-125 | 10 |
| W-187 | 5,100 | Ar-37 | 5.3 |
| W-181 | 1,400 | Cs-127 | 4.8 |
| W-178 | 440 | Te-121 | 4.3 |
| Xe-127 | 24 | I-123 | 3.8 |
| W-177 | 22 | Kr-79 | 3.4 |
| W-176 | 20 | Re-186 | 3.4 |
| Cs-131 | 18 | I-131 | <1 |
| Xe-125 | 14 | I-133 | <1 |
| Cs-129 | 12 | I-135 | <1 |

Source: SNL 1995a.

**TABLE F.2.1.4.2–3.—*Full Accelerator Production of Tritium with the Helium-3 Target System High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | $1.3x10^{-5}$ | $1.9x10^{-10}$ | 0.018 | $9.0x10^{-6}$ | $1.0x10^{-4}$ |
| NTS | $3.5x10^{-5}$ | $6.0x10^{-8}$ | $1.8x10^{-3}$ | $9.0x10^{-7}$ | $1.0x10^{-4}$ |
| ORR | $2.6x10^{-4}$ | $5.5x10^{-9}$ | 0.18 | $9.0x10^{-5}$ | $1.0x10^{-4}$ |
| Pantex Plant | $1.7x10^{-4}$ | $3.5x10^{-9}$ | 0.022 | $1.1x10^{-5}$ | $1.0x10^{-4}$ |
| SRS | $1.1x10^{-5}$ | $2.3x10^{-10}$ | 0.068 | $3.4x10^{-5}$ | $1.0x10^{-4}$ |

[a] All values are mean values.

**TABLE F.2.1.4.2–4.—*Phased Accelerator Production of Tritium with the Helium-3 Target System High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | $1.3x10^{-5}$ | $1.9x10^{-10}$ | 0.018 | $9.0x10^{-6}$ | $1.0x10^{-4}$ |
| NTS | $3.5x10^{-5}$ | $6.0x10^{-10}$ | $1.8x10^{-3}$ | $9.0x10^{-7}$ | $1.0x10^{-4}$ |
| ORR | $2.6x10^{-4}$ | $5.5x10^{-9}$ | 0.18 | $9.0x10^{-5}$ | $1.0x10^{-4}$ |
| Pantex Plant | $1.7x10^{-4}$ | $3.5x10^{-9}$ | 0.022 | $1.1x10^{-5}$ | $1.0x10^{-4}$ |
| SRS | $1.1x10^{-5}$ | $2.3x10^{-10}$ | 0.068 | $3.4x10^{-5}$ | $1.0x10^{-4}$ |

[a] All values are mean values.

### F.2.1.4.3 *Spallation-Induced Lithium Conversion Target System*

**Scenario.** The high consequence accident for the Full APT with the spallation-induced lithium conversion target system configuration is a large break loss of coolant accident, followed by a successful beam trip, but total failure of the active and passive cooling systems was postulated. This scenario would lead to partial melting of the target. Based on these analyses, a bounding source term release to the environment was determined. Table F.2.1.4.3–1 presents the source term released during the accident. The analysis did not estimate the accident annual frequency of occurrence (SNL 1995a:8-12–8-14).

The postulated accident sequence assumed that the only safety system to function is the passive water dump tank that floods the target room in the event of a loss of coolant accident. The probability of the accident is in the residual risk category, but it is within the design basis of confinement (SNL 1995a:8-12). The evaluation to bound the accident frequency of occurrence assumed that the APT safety systems were designed to remain functional following a design basis earthquake or a safe shutdown earthquake with a return frequency of $1.0 \times 10^{-4}$ per year. The evaluation also assumed that the APT pressure boundary will fail but some of the passive safety systems may survive an earthquake with a return frequency of $1.0 \times 10^{-5}$ per year. Catastrophic failure of passive safety systems could be expected after an earthquake with a return frequency of $1.0 \times 10^{-6}$ per year. Since the accident source term assumed that some of the safety systems are functional following the initiating event, the annual frequency of occurrence for the postulated accident is estimated to be in the $1.0 \times 10^{-4}$ to $1.0 \times 10^{-5}$ per year range. For the purpose of calculating the point estimate of risk for the postulated accident, the accident annual frequency of occurrence is assumed to be $1.0 \times 10^{-4}$ per year, the return frequency for the design basis earthquake.

**Consequences.** The estimated consequences of the postulated APT with spallation-induced lithium conversion target system accident for each site are shown in table F.2.1.4.3–2. Figure F.2.1.4.3–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from

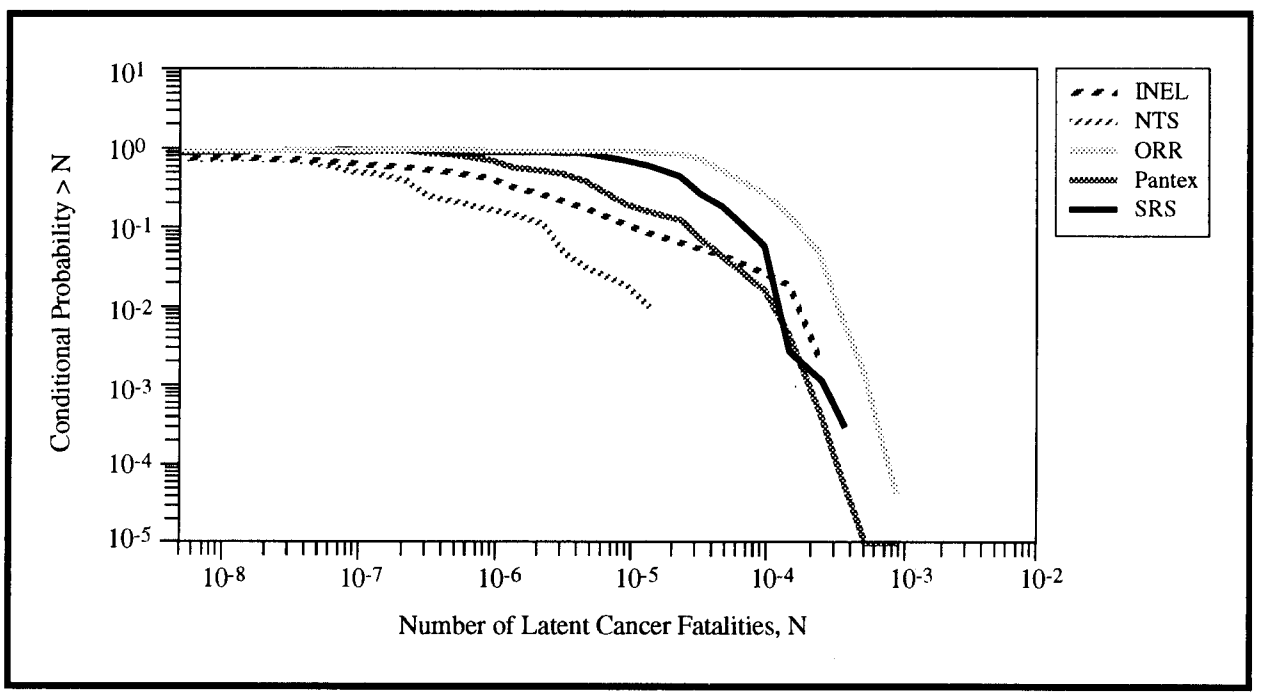


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**FIGURE F.2.1.4.3–1.—*Full Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.4.3–1.—*Source Term for Full Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System High Consequence Accident***

| Isotope | Released Activity (curies) | Isotope | Released Activity (curies) |
|---|---|---|---|
| H-3 | 1900 | I-123 | 101 |
| Hg-197 | 1065 | I-126 | 84 |
| F-18 | 1039 | Br-84 | 83 |
| Kr-83m | 1039 | Br-77 | 79 |
| Hg-195 | 518 | Xe-122 | 77 |
| Kr-79 | 477 | I-121 | 76 |
| Xe-125 | 465 | I-124 | 64 |
| Xe-127 | 320 | I-120 | 55 |
| Kr-88 | 259 | I-130 | 54 |
| Kr-85m | 258 | I-128 | 45 |
| Br-83 | 243 | Hg-197m | 40 |
| Kr-87 | 221 | I-122 | 38 |
| Hg-193 | 211 | I-131 | 27 |
| Br-82 | 193 | Hg-195m | 20 |
| Br-76 | 177 | Hg-190 | 14 |
| Hg-203 | 136 | I-133 | 13 |
| Hg-192 | 115 | I-135 | 12 |
| I-125 | 113 | | |

Source: SNL 1995a.

**TABLE F.2.1.4.3–2.—*Full Size Accelerator Production of Tritium with Spallation-Induced Lithium Conversion Target System Bounding High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Average Individual Risk of Cancer | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | $1.6 \times 10^{-4}$ | $1.5 \times 10^{-9}$ | 0.10 | $5.0 \times 10^{-5}$ | $1.0 \times 10^{-4}$ |
| NTS | $4.0 \times 10^{-4}$ | $4.5 \times 10^{-9}$ | 0.011 | $5.5 \times 10^{-6}$ | $1.0 \times 10^{-4}$ |
| ORR | $2.6 \times 10^{-3}$ | $4.1 \times 10^{-8}$ | 0.12 | $6.0 \times 10^{-5}$ | $1.0 \times 10^{-4}$ |
| Pantex Plant | $1.6 \times 10^{-3}$ | $2.6 \times 10^{-8}$ | 0.15 | $7.5 \times 10^{-5}$ | $1.0 \times 10^{-4}$ |
| SRS | $1.2 \times 10^{-4}$ | $1.7 \times 10^{-9}$ | 0.43 | $2.2 \times 10^{-4}$ | $1.0 \times 10^{-4}$ |

[a] All values are mean values.

an APT with spallation-induced lithium conversion target severe accident exceeds the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis of the source term in table F.2.1.4.3–1 using the MACCS computer code.

### F.2.1.5 *Tritium Target Extraction Facility*

**Scenario.** A tritium extraction facility removes tritium from targets. The accidents for the tritium extraction facility are based on the analysis of tritium operation at SRS. The high consequence accident for the facility postulated a beyond design basis earthquake that caused the release of major portions of the process vessel tritium inventory. Approximately

$2.4 \times 10^6$ Ci of tritium in oxide form could be released to the environment. The accident annual frequency of occurrence is estimated at $1.4 \times 10^{-4}$ per year at SRS (DOE 1995d).

The accident annual frequency of occurrence for new facilities at the other candidate sites will be less than the frequency for existing facilities at SRS. It is assumed that the process systems, tanks, and confinement systems will be designed to maintain functional integrity following a design basis earthquake or a safe shutdown earthquake with a return frequency of $1.0 \times 10^{-4}$ per year. The evaluation also assumed that the process system pressure boundary and/or some of the active or passive safety systems may survive an earthquake with a return frequency of $1.0 \times 10^{-5}$ per year but catastrophic failure of the facility could be expected after an earthquake with a return frequency of $1.0 \times 10^{-6}$ per year. For the purpose of calculating the point estimate of risk for the postulated accident, the accident annual frequency of occurrence for all new facilities is assumed to be $1.0 \times 10^{-6}$ per year.

**Consequences.** The estimated consequences of the postulated tritium target extraction facility accident for each site are shown in table F.2.1.5–1. Figure F.2.1.5–1 presents the cancer fatalities complementary cumulative distribution functions. The curves show the probability that the number of cancer fatalities that may result from a severe accident exceeds the value "N" on the horizontal axis. The curves assume that the accident has occurred. NTS can be seen to have the lowest number of cancer fatalities in the event of this accident. The dose and cancer fatality estimates are based on analysis to the release of $2.4 \times 10^6$ Ci of tritium in the oxide form using the MACCS computer code.

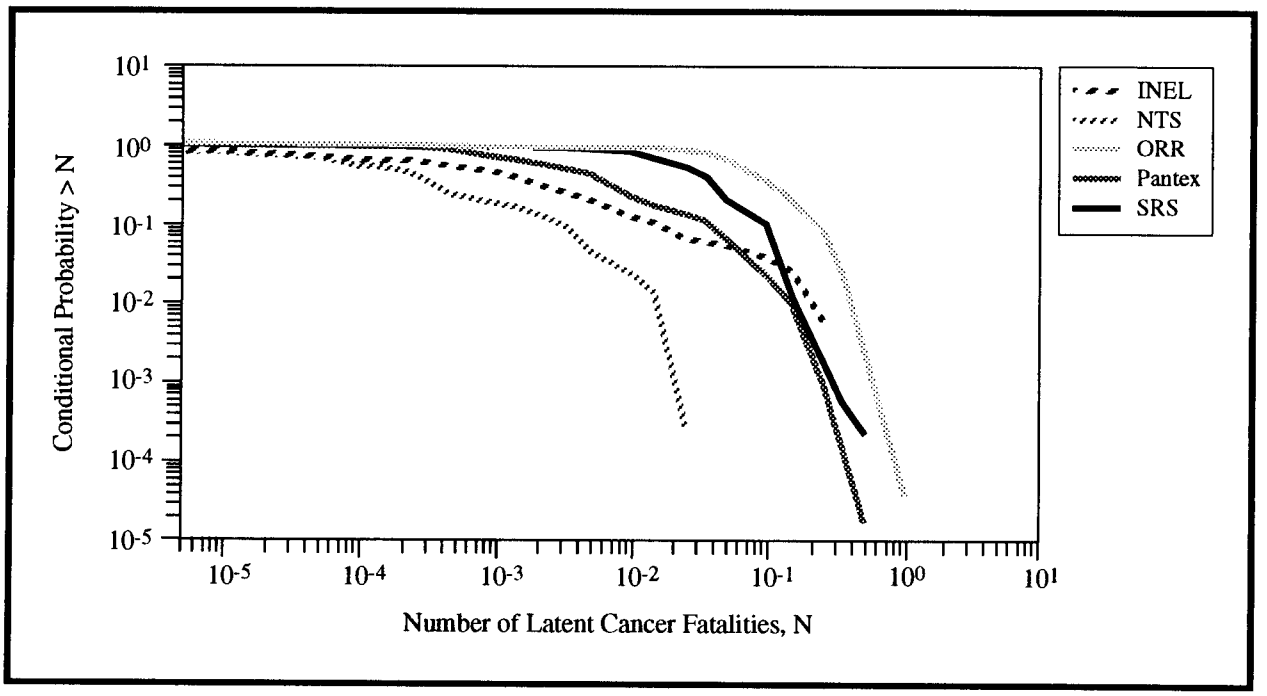


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**FIGURE F.2.1.5–1.—*Tritium Target Extraction Facility High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.1.5–1.—*Tritium Target Extraction Facility High Consequence Accident*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| **Site** | **Dose (rem)** | **Average Individual Risk of Cancer** | **Dose (person-rem)** | **Cancer Fatality** | **Accident Frequency (per year)** |
| INEL | $3.9 \times 10^{-3}$ | $2.3 \times 10^{-7}$ | 23 | 0.012 | $1.0 \times 10^{-6}$ |
| NTS | 0.039 | $7.0 \times 10^{-7}$ | 2.3 | $1.2 \times 10^{-3}$ | $1.0 \times 10^{-6}$ |
| ORR | 0.30 | $6.5 \times 10^{-6}$ | 220 | 0.11 | $1.0 \times 10^{-6}$ |
| Pantex Plant | 0.19 | $4.3 \times 10^{-6}$ | 28 | 0.014 | $1.0 \times 10^{-6}$ |
| SRS | 0.013 | $2.8 \times 10^{-7}$ | 86 | 0.043 | $1.4 \times 10^{-4}$ |

[a] All values are mean values.

## F.2.2 Tritium Supply and Recycling Facility Low to Moderate Consequence Accidents

Low to moderate consequence accidents for candidate tritium supply technologies and recycling facilities at potential sites (INEL, NTS, ORR, Pantex, and SRS) have been evaluated using the GENII computer code. The consequences are based on inhalation and external dose pathways. Ingestion pathways are modeled but not included because it is assumed the food and water supply will be interdicted. The details of the evaluation are presented in sections F.2.2.1 through F.2.2.5.

### F.2.2.1 *Heavy Water Reactor*

**Scenario.** The HWR moderate to low consequence accident occurs due to a charge-and-discharge mishap. During refueling operations, an irradiated fuel assembly containing tritium targets is assumed to melt in air in the hot cell refueling canyon, due to an assumed failure of the crane motive systems and the water-delivery systems that are used to cool the fuel assembly. Initially, the hot cell vents to the environment through filters. After 1 minute, the hot cell is isolated and leaks into the containment, which in turn leaks to the environment at the rate of 0.1 percent of its volume per day. Table F.2.2.1–1 presents the source term released during the accident. The analysis did not estimate the accident annual frequency (DOE 1995d:B-3).

**Consequences.** The estimated consequences of the postulated accident at each site are shown in table F.2.2.1–2 and F.2.2.1–3 for 50 percent and 95 percent meteorology conditions. The dose estimates are based on analysis of the source term in table F.2.2.1–1 using the GENII computer code.

TABLE F.2.2.1–1.—*Source Term for Heavy Water Reactor Charge/Discharge Accident*

| Isotope | Released Activity (curies) | Isotope | Released Activity (curies) |
|---|---|---|---|
| H-3 | $2.61 \times 10^{3}$ | Xe-135 | 24.7 |
| Br-83 | 0.0615 | I-129 | $2.69 \times 10^{-6}$ |
| Br-83 | $4.21 \times 10^{-8}$ | I-131 | 70.5 |
| Kr-83m | 1.90 | I-132 | 0.145 |
| Kr-85 | 11.9 | I-133 | 10.4 |
| Kr-85m | 54.0 | I-134 | $2.47 \times 10^{-4}$ |
| Kr-87 | 0.45 | I-135 | 3.11 |
| Kr-88 | 41.3 | Cs-134 | 26.5 |
| Rb-86 | 0.124 | Cs-136 | 0.94 |
| Xe-131m | 15.4 | Cs-137 | 9.69 |
| Xe-133 | $2.90 \times 10^{3}$ | Cs-138 | $1.00 \times 10^{-7}$ |
| Xe-133m | 558 | Cs-139 | $1.62 \times 10^{-26}$ |

Source: DOE 1995d.

TABLE F.2.2.1–2.—*Heavy Water Reactor Charge/Discharge Accident Consequence with 50 Percent Meteorology Conditions*[a]

| | Maximum Offsite Individual | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 0.02 | $9.9 \times 10^{-6}$ | 180 | 0.092 | [b] |
| NTS | 8.4 | $4.2 \times 10^{-6}$ | 3.2 | $1.6 \times 10^{-3}$ | [b] |
| ORR | 0.14 | $6.8 \times 10^{-5}$ | $1.6 \times 10^{3}$ | 0.80 | [b] |
| Pantex Plant | 0.015 | $7.4 \times 10^{-6}$ | 52 | 0.026 | [b] |
| SRS | 0.046 | $2.3 \times 10^{-5}$ | $1.5 \times 10^{3}$ | 0.74 | [b] |

[a] Values shown are for inhalation and external doses only.

[b] Data not available. The value is expected to be in the $1.0 \times 10^{-2}$ to $1.0 \times 10^{-4}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-2}$ per year.

**TABLE F.2.2.1–3.—*Heavy Water Reactor Charge/Discharge Accident Consequence with 95 Percent Meteorology Conditions*[a]**

| Site | Maximum Offsite Individual Dose (rem) | Maximum Offsite Individual Cancer Fatality | Population to 50 Miles Dose (person-rem) | Population to 50 Miles Cancer Fatality | Accident Frequency (per year) |
|---|---|---|---|---|---|
| INEL | 0.071 | $3.5 \times 10^{-5}$ | $1.1 \times 10^{3}$ | 0.57 | b |
| NTS | 0.33 | $1.7 \times 10^{-4}$ | 140 | 0.068 | b |
| ORR | 1.1 | $5.6 \times 10^{-4}$ | $9.6 \times 10^{3}$ | 4.8 | b |
| Pantex Plant | 0.88 | $4.4 \times 10^{-4}$ | $4.0 \times 10^{3}$ | 2.0 | b |
| SRS | 0.68 | $3.4 \times 10^{-4}$ | $3.2 \times 10^{4}$ | 16 | b |

[a] Values shown are for inhalation and external doses only.

[b] Data not available. The value is expected to be in the $<1.0 \times 10^{-2}$ to $1.0 \times 10^{-4}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-2}$ per year.

### F.2.2.2 *Modular High Temperature Gas-Cooled Reactor*

**Scenario.** The MHTGR low to moderate consequence accident is a large break in the primary-system piping, releasing the circulating and plateout radioactive material into containment. The initial containment leak rate is assumed to be 100 percent per day. After approximately 50 hours, the containment is isolated and the leak rate reduces to 1 percent per day. Table F.2.2.2–1 presents the source term released during the accident. The analysis did not estimate the accident annual frequency (DOE 1995e:B-3).

**Consequences.** The estimated consequences of the postulated accident at each site are shown in table F.2.2.2–2 and F.2.2.2–3 for 50 percent and 95 percent meteorology conditions. The dose estimates are based on analysis of the source term in table F.2.2.2–1 using the GENII computer code.

**TABLE F.2.2.2–1.—*Source Term for Modular High Temperature Gas-Cooled Reactor Low to Moderate Consequence Accident***

| Isotope | Released Activity (curies) | Isotope | Released Activity (curies) | Isotope | Released Activity (curies) |
|---|---|---|---|---|---|
| H-3[a] | $7.2 \times 10^{4}$ | Mo-99 | 11 | I-132 | 21 |
| Kr-85m | 1.3 | Tc-99m | $8.9 \times 10^{-4}$ | I-133 | 15 |
| Kr-85 | 0.014 | Ru-103 | 17 | I-134 | 0.51 |
| Kr-87 | 0.89 | Ru-105 | $1.5 \times 10^{-5}$ | I-135 | 5.0 |
| Kr-88 | 2.7 | Ru-106 | 1.2 | Xe-133 | 2.5 |
| Kr-89 | 0.022 | Rh-105 | 1.1 | Xe-135 | 2.1 |
| Kr-90 | $1.6 \times 10^{-3}$ | Ag-110m | 0.01 | Cs-134 | 4.4 |
| Rb-86 | 1.6 | Sb-127 | 0.48 | Cs-136 | 3.0 |
| Sr-89 | 24 | Sb-129 | $5.3 \times 10^{-8}$ | Cs-137 | 2.0 |
| Sr-90 | 2.6 | Te-127m | 0.81 | Ba-140 | 18 |
| Sr-91 | 0.032 | Te-127 | 9.9 | La-140 | 6.7 |
| Y-90 | 0.56 | Te-129m | 2.1 | Ce-141 | 27 |
| Y-91 | 27 | Te-129 | 0.076 | Ce-143 | 3.7 |
| Zr-95 | 30 | Te-131m | 1.2 | Ce-144 | 9.6 |
| Zr-97 | 0.59 | Te-132 | 80 | Pr-143 | 23 |
| Nb-95 | 29 | I-131 | 28 | Nd-147 | 8.8 |

[a] Tritiated water equivalent.

Source: DOE 1995e.

**TABLE F.2.2.2–2.—*Modular High Temperature Gas-Cooled Reactor Low to Moderate Consequence Accident with 50 Percent Meteorology Conditions*[a]**

| Site | Maximum Offsite Individual Dose (rem) | Maximum Offsite Individual Cancer Fatality | Population to 50 Miles Dose (person-rem) | Population to 50 Miles Cancer Fatality | Accident Frequency (per year) |
|---|---|---|---|---|---|
| INEL | 0.022 | $1.1 \times 10^{-5}$ | 200 | 0.1 | b |
| NTS | $9.1 \times 10^{-3}$ | $4.6 \times 10^{-6}$ | 3.4 | $1.7 \times 10^{-3}$ | b |
| ORR | 0.18 | $9.2 \times 10^{-5}$ | $2.0 \times 10^{3}$ | 1.0 | b |
| Pantex Plant | 0.016 | $8.1 \times 10^{-6}$ | 68 | 0.034 | b |
| SRS | 0.059 | $3.0 \times 10^{-5}$ | $2.0 \times 10^{3}$ | 1.0 | b |

[a] Values shown are for inhalation and external doses only.
[b] Data not available. The value is expected to be in the $1.0 \times 10^{-2}$ to $1.0 \times 10^{-4}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-2}$ per year.

**TABLE F.2.2.2–3.—*Modular High Temperature Gas-Cooled Reactor Low to Moderate Consequence Accident with 95 Percent Meteorology Conditions*[a]**

| Site | Maximum Offsite Individual Dose (rem) | Maximum Offsite Individual Cancer Fatality | Population to 50 Miles Dose (person-rem) | Population to 50 Miles Cancer Fatality | Accident Frequency (per year) |
|---|---|---|---|---|---|
| INEL | 0.078 | $3.9 \times 10^{-5}$ | $1.2 \times 10^{3}$ | 0.62 | b |
| NTS | 0.36 | $1.8 \times 10^{-4}$ | 150 | 0.074 | b |
| ORR | 1.5 | $7.4 \times 10^{-4}$ | $1.3 \times 10^{4}$ | 6.3 | b |
| Pantex Plant | 0.97 | $4.9 \times 10^{-4}$ | $5.3 \times 10^{3}$ | 2.7 | b |
| SRS | 0.90 | $4.5 \times 10^{-4}$ | $4.1 \times 10^{4}$ | 21 | b |

[a] Values shown are for inhalation and external doses only.
[b] Data not available. The value is expected to be in the $1.0 \times 10^{-2}$ to $1.0 \times 10^{-4}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-2}$ per year.

### F.2.2.3 *Advanced Light Water Reactor*

**Scenario.** The ALWR low to moderate consequence accident is a large pipe break in the primary coolant system. This results in a rapid discharge of reactor coolant from the broken pipe into containment. Any radioactive material contained in the coolant or released to the coolant as a result of fuel cladding failures would escape to the containment. Table F.2.2.3–1 presents the source term released during the accident for the Advanced Boiling Water Reactor, AP600, and Simplified Boiling Water Reactor ALWR options. Data was not available for the CE System 80+ ALWR option. The analysis did not estimate the accidental annual frequency of occurrence (DOE 1995f:22-23). It is expected that the postulated accident annual frequency of occurrence would be in the $1.0 \times 10^{-3}$ to $1.0 \times 10^{-5}$ per year range. For the purpose of calculating the point estimate of risk for the postulated accident, the accident annual frequency of occurrence is assumed to be $1.0 \times 10^{-3}$ per year.

**Consequences.** The estimated consequences of the postulated accident at each site are shown in tables F.2.2.3–2 through F.2.2.3–4 for the Advanced Boiling Water Reactor, AP600, and Simplified Boiling Water Reactor ALWR options with 50 percent meteorology conditions during the accident and tables F.2.2.3–5 through F.2.2.3–7 for the Advanced Boiling Water Reactor, AP600, and Simplified Boiling Water Reactor, ALWR options with 95 percent meteorology conditions. The dose estimates are based on analysis of the source terms in table F.2.2.3–1 using the GENII computer code.

**TABLE F.2.2.3–1.—*Source Term for Advanced Light Water Reactor Options Low to Moderate Consequence Accident* [Page 1 of 2]**

| | 0-2 hour Release in Curies | | |
|---|---|---|---|
| | Large | Small | |
| Isotope | Advanced Boiling Water Reactor | AP600 | Simplified Boiling Water Reactor |
| I-130 | 0.0 | 1.6 | 0.0 |
| I-131 | 260 | 120 | 12 |
| I-132 | 350 | 170 | 11 |
| I-133 | 540 | 220 | 24 |
| I-134 | 510 | 70 | 8.0 |
| I-135 | 510 | 180 | 20 |
| Xe-131m | 21 | 1.9 | 0.33 |
| Xe-133m | 300 | 78 | 4.6 |
| Xe-133 | $7.6 \times 10^{3}$ | 540 | 120 |
| Xe-135m | 490 | 1.5 | 0.52 |
| Xe-135 | 930 | 160 | 20 |
| Xe-137 | 510 | 0.0 | $5.7 \times 10^{-3}$ |
| Xe-138 | $2.0 \times 10^{3}$ | 4.6 | 1.8 |
| Kr-83m | 330 | 0.0 | 3.8 |
| Kr-85m | 840 | 54 | 12 |
| Kr-85 | 41 | 2.7 | 0.92 |
| Kr-87 | 130 | 55 | 13 |
| Kr-88 | $2.1 \times 10^{3}$ | 130 | 29 |
| Kr-89 | 180 | 0.0 | $9.7 \times 10^{-4}$ |
| Sr-87m | 0.0 | 0.0 | $1.6 \times 10^{-7}$ |
| Sr-89 | 0.0 | 1.2 | 0.16 |
| Sr-90 | 0.0 | 0.099 | 0.022 |
| Sr-91 | 0.0 | 0.0 | 0.18 |
| Sr-92 | 0.0 | 0.0 | 0.14 |
| Ru-103 | 0.0 | 2.0 | 0.23 |
| Ru-105 | 0.0 | 0.0 | 0.11 |
| Ru-106 | 0.0 | 0.66 | 0.082 |
| Te-123m | 0.0 | 0.0 | $1.1 \times 10^{-8}$ |
| Te-125m | 0.0 | 0.0 | $7.1 \times 10^{-3}$ |
| Te-127 | 0.0 | 0.0 | 0.21 |
| Te-127m | 0.0 | 0.0 | 0.037 |
| Te-129 | 0.0 | 0.0 | 0.32 |
| Te-129m | 0.0 | 2.1 | 0.23 |
| Te-131 | 0.0 | 0.0 | 0.21 |
| Te-131m | 0.00 | 3.6 | 0.41 |
| Te-132 | 0.0 | 35 | 4.2 |
| Te-133 | 0.0 | 0.0 | 0.044 |
| Te-133m | 0.0 | 0.0 | 0.73 |
| Te-134 | 0.0 | 0.0 | 1.2 |
| Cs-134 | 0.0 | 15 | 3.4 |
| Cs-134m | 0.0 | 0.0 | 0.59 |

**TABLE F.2.2.3–1.—*Source Term for Advanced Light Water Reactor Options Low to Moderate Consequence Accident* [Page 2 of 2]**

| | 0-2 hour Release in Curies | | |
|---|---|---|---|
| | Large | Small | |
| Isotope | Advanced Boiling Water Reactor | AP600 | Simplified Boiling Water Reactor |
| Cs-135 | 0.0 | 0.0 | $5.5 \times 10^{-14}$ |
| Cs-136 | 0.0 | 4.7 | 0.59 |
| Cs-137 | 0.0 | 10 | 2.2 |
| Cs-138 | 0.0 | 0.0 | 3.1 |
| Ba-139 | 0.0 | 0.0 | 0.12 |
| Ba-140 | 0.0 | 0.0 | 0.28 |
| Ba-141 | 0.0 | 0.0 | $9.4 \times 10^{-3}$ |
| Ba-142 | 0.0 | 0.0 | $1.6 \times 10^{-3}$ |
| Ce-141 | 0.0 | 0.0 | $2.6 \times 10^{-3}$ |
| Ce-143 | 0.0 | 0.0 | $2.4 \times 10^{-3}$ |
| Ce-144 | 0.0 | 0.0 | $2.2 \times 10^{-3}$ |
| La-140 | 0.0 | 0.0 | $2.8 \times 10^{-3}$ |
| La-141 | 0.0 | 0.0 | $1.9 \times 10^{-3}$ |
| La-142 | 0.0 | 0.0 | $1.2 \times 10^{3}$ |
| H-3 | $1.3 \times 10^{3}$ | 160 | 58 |

Source: DOE 1995f.

**TABLE F.2.2.3–2.—*Advanced Boiling Water Reactor Low to Moderate Consequence Accident with 50 Percent Meteorology Conditions*[a]**

| | Maximum Offsite Individual | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 5.1 | $2.5 \times 10^{-3}$ | $4.5 \times 10^{4}$ | 23 | [b] |
| NTS | 2.3 | $1.1 \times 10^{-3}$ | 830 | 0.41 | [b] |
| ORR | 44 | 0.044 | $4.9 \times 10^{5}$ | 240 | [b] |
| Pantex Plant | 3.9 | $2.0 \times 10^{-3}$ | $1.6 \times 10^{4}$ | 8.0 | [b] |
| SRS | 14 | $7.1 \times 10^{-3}$ | $4.6 \times 10^{5}$ | 230 | [b] |

[a] Values shown are for inhalation and external doses only.

[b] Data not available. The value is expected to be in the $1.0 \times 10^{-3}$ to $1.0 \times 10^{-5}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-3}$ per year.

**TABLE F.2.2.3–3.—*AP600 Advanced Light Water Reactor Low to Moderate Consequence Accident with 50 Percent Meteorology Conditions*[a]**

| Site | Maximum Offsite Individual Dose (rem) | Maximum Offsite Individual Cancer Fatality | Population to 50 Miles Dose (person-rem) | Population to 50 Miles Cancer Fatality | Accident Frequency (per year) |
|---|---|---|---|---|---|
| INEL | 0.62 | $3.1 \times 10^{-4}$ | $5.5 \times 10^{3}$ | 2.8 | [b] |
| NTS | 0.28 | $1.4 \times 10^{-4}$ | 100 | 0.05 | [b] |
| ORR | 5.4 | $2.7 \times 10^{-3}$ | $6.0 \times 10^{4}$ | 30 | [b] |
| Pantex Plant | 0.49 | $2.4 \times 10^{-4}$ | $2.0 \times 10^{3}$ | 0.98 | [b] |
| SRS | 1.8 | $8.9 \times 10^{-4}$ | $5.6 \times 10^{4}$ | 28 | [b] |

[a] Values shown are for inhalation and external doses only.

[b] Data not available. The value is expected to be in the $1.0 \times 10^{-3}$ to $1.0 \times 10^{-5}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-3}$ per year.

**TABLE F.2.2.3–4.—*Simplified Boiling Water Reactor Low to Moderate Consequence Accident with 50 Percent Meteorology Conditions*[a]**

| Site | Maximum Offsite Individual Dose (rem) | Maximum Offsite Individual Cancer Fatality | Population to 50 Miles Dose (person-rem) | Population to 50 Miles Cancer Fatality | Accident Frequency (per year) |
|---|---|---|---|---|---|
| INEL | 0.23 | $1.1 \times 10^{-4}$ | $2.1 \times 10^{3}$ | 1.1 | [b] |
| NTS | 0.098 | $4.9 \times 10^{-4}$ | 37 | 0.018 | [b] |
| ORR | 1.9 | $9.7 \times 10^{-4}$ | $2.2 \times 10^{4}$ | 11 | [b] |
| Pantex Plant | 0.18 | $8.9 \times 10^{-5}$ | 730 | 0.36 | [b] |
| SRS | 0.64 | $3.2 \times 10^{-4}$ | $2.1 \times 10^{4}$ | 11 | [b] |

[a] Values shown are for inhalation and external doses only.

[b] Data not available. The value is expected to be in the $1.0 \times 10^{-3}$ to $1.0 \times 10^{-5}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-3}$ per year.

**TABLE F.2.2.3–5.—*Advanced Boiling Water Reactor Low to Moderate Consequence Accident with 95 Percent Meteorology Conditions*[a]**

| Site | Maximum Offsite Individual Dose (rem) | Maximum Offsite Individual Cancer Fatality | Population to 50 Miles Dose (person-rem) | Population to 50 Miles Cancer Fatality | Accident Frequency (per year) |
|---|---|---|---|---|---|
| INEL | 19 | $9.4 \times 10^{-3}$ | $2.9 \times 10^{5}$ | 140 | [b] |
| NTS | 91 | 0.091 | $3.5 \times 10^{4}$ | 18 | [b] |
| ORR | 350 | 0.35 | $2.9 \times 10^{6}$ | $1.5 \times 10^{3}$ | [b] |
| Pantex Plant | 230 | 0.23 | $1.3 \times 10^{6}$ | 640 | [b] |
| SRS | 210 | 0.21 | $9.2 \times 10^{6}$ | $4.6 \times 10^{3}$ | [b] |

[a] Values shown are for inhalation and external doses only.

[b] Data not available. The value is expected to be in the $1.0 \times 10^{-3}$ to $1.0 \times 10^{-5}$ per year range. For calculational purposes, the value is assumed to be $1.0 \times 10^{-3}$ per year.

**TABLE F.2.2.3–6.—*AP600 Advanced Light Water Reactor Low to Moderate Consequence Accident with 95 Percent Meteorology Conditions*[a]**

| | Maximum Offsite Individual | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 2.4 | $1.2x10^{-3}$ | $3.6x10^{4}$ | 18 | b |
| NTS | 12 | $5.8x10^{-3}$ | $4.3x10^{3}$ | 2.1 | b |
| ORR | 44 | 0.044 | $3.7x10^{5}$ | 190 | b |
| Pantex Plant | 29 | 0.029 | $1.6x10^{5}$ | 82 | b |
| SRS | 25 | 0.025 | $1.1x10^{6}$ | 550 | b |

[a] Values shown are for inhalation and external doses only.
[b] Data not available. The value is expected to be in the $1.0x10^{-3}$ to $1.0x10^{-5}$ per year range. For calculational purposes, the value is assumed to be $1.0x10^{-3}$ per year.

**TABLE F.2.2.3–7.—*Simplified Boiling Water Reactor Low to Moderate Consequence Accident with 95 Percent Meteorology Conditions*[a]**

| | Maximum Offsite Individual | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | 0.85 | $4.3x10^{-4}$ | $1.3x10^{4}$ | 6.6 | b |
| NTS | 4.1 | $2.0x10^{-3}$ | $1.6x10^{3}$ | 0.82 | b |
| ORR | 16 | $8.0x10^{-3}$ | $1.4x10^{5}$ | 68 | b |
| Pantex Plant | 10 | $5.2x10^{-3}$ | $5.7x10^{4}$ | 29 | b |
| SRS | 9.6 | $4.8x10^{-3}$ | $4.4x10^{5}$ | 220 | b |

[a] Values shown are for inhalation and external doses only.
[b] Data not available. The value is expected to be in the $1.0x10^{-3}$ to $1.0x10^{-5}$ per year range. For calculational purposes, the value is assumed to be $1.0x10^{-3}$ per year.

### F.2.2.4 *Accelerator Production of Tritium*

#### F.2.2.4.1 *Accelerator and Beam Transport System*

One design basis accident for the accelerator was considered. Incorrect administrative procedures and control for maintenance access to activated accelerator components could result in higher than permitted dose levels to service personnel. The consequences of the accident are limited to the dose received by service personnel. No lost production time or equipment replacement expense would be incurred. Based on operating APT experience, the annual frequency of occurrence is estimated at 1.0 time per year (SNL 1995a:8-5).

#### F.2.2.4.2 *Helium-3 Target System*

**Scenario.** The low to moderate consequence accident for the this APT technology is a double-ended guillotine cold leg break near the pump discharge. The plant protection and safety systems performed as designed. The analysis assumed the most limiting single failure was the loss of power to one of the residual heat removal pumps. During this accident, the rod temperatures flatten out at approximately 340 °Kelvin (152 °F) and would be expected to decrease in time as the power decays. The source term to the confinement for this design basis accident is judged to be similar to and bounded by the source term for the beyond design basis accident (large break low to moderate consequence) presented in section F.2.1.4.2. The analysis did not estimate the accident annual frequency of occurrence (SNL 1995a:8-8).

**Consequences.** The estimated consequences of the postulated APT with helium-3 target system low to moderate consequence accident are bounded by the beyond design basis accident presented in section F.2.1.4.3.

#### F.2.2.4.3 *Spallation-Induced Lithium Conversion Target System*

The low to moderate consequence accident for the APT technology is a large break in the primary coolant system. The analysis assumed that all plant protection systems functioned as designed. The worst single failure responding to the initiating event was assumed. The source term for this accident will consist of a small fraction of the radioactivity inventory released from the heavy-water coolant that is expelled into the confinement. The radionuclides released to the confinement are minimal. The analysis did not estimate the accident annual frequency of occurrence (SNL 1995a:8-6).

### F.2.2.5 *Tritium Target Extraction Facility*

**Scenario.** A tritium target extraction facility removes tritium from the targets. The bounding accidents for the tritium extraction facility are based on the analysis of tritium operations at SRS. The bounding low to moderate consequence accident for the facility postulated an explosion in the extraction facility. Air leakage from furnace leaks, tanks leaks, connection leaks, pumps leaks valve, or during process maintenance forms a flammable mixture that subsequently ignites. Approximately $1.4 \times 10^6$ Ci of tritium in oxide form could be released to the material handling room and subsequently to the environment. The accident annual frequency of occurrence is estimated at $2.0 \times 10^{-5}$ per year at SRS (DOE 1994a).

**Consequences.** The estimated consequences of the postulated tritium target extraction facility bounding accident for each site are shown in table F.2.2.5-1 and F.2.2.5–2 for 50 percent and 95 percent meteorology conditions. The estimates are based on the postulated release of $1.4 \times 10^6$ Ci of tritium in the oxide form directly to the environment during the accident using the GENII computer code.

**TABLE F.2.2.5–1.—*Tritium Target Extraction Facility Bounding Low to Moderate Consequence Accident with 50 Percent Meteorology Conditions*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (Per year) |
| INEL | 0.099 | $5.0 \times 10^{-5}$ | 990 | 0.5 | $2.0 \times 10^{-5}$ |
| NTS | 0.043 | $2.2 \times 10^{-5}$ | 16 | $8.0 \times 10^{-3}$ | $2.0 \times 10^{-5}$ |
| ORR | 0.84 | $4.2 \times 10^{-4}$ | $9.9 \times 10^{3}$ | 5.0 | $2.0 \times 10^{-5}$ |
| Pantex Plant | 0.077 | $3.9 \times 10^{-5}$ | 320 | 0.16 | $2.0 \times 10^{-5}$ |
| SRS | 0.23 | $1.2 \times 10^{-4}$ | $1.2 \times 10^{4}$ | 6.0 | $2.0 \times 10^{-5}$ |

[a] Values shown are for inhalation and external doses only.

**TABLE F.2.2.5–2.—*Tritium Target Extraction Facility Bounding Low to Moderate Consequence Accident with 95 Percent Meteorology Conditions*[a]**

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (Per year) |
| INEL | 0.37 | $1.9 \times 10^{-4}$ | $5.9 \times 10^{3}$ | 3.0 | $2.0 \times 10^{-5}$ |
| NTS | 1.8 | $9.0 \times 10^{-4}$ | 720 | 0.36 | $2.0 \times 10^{-5}$ |
| ORR | 7.0 | $3.5 \times 10^{-3}$ | $6.0 \times 10^{4}$ | 30 | $2.0 \times 10^{-5}$ |
| Pantex Plant | 4.5 | $2.3 \times 10^{-3}$ | $2.5 \times 10^{-4}$ | 13 | $2.0 \times 10^{-5}$ |
| SRS | 4.3 | $2.2 \times 10^{-3}$ | $2.5 \times 10^{5}$ | 130 | $2.0 \times 10^{-5}$ |

[a] Values shown are for inhalation and external doses only.

### F.2.3 Tritium Recycling Facility High Consequence Accident

The bounding accidents selected for the tritium recycling facility are based on the analysis of tritium operations at SRS. While the spectrum of accidents is representative of the types of accidents to be considered in the design, development and analysis of the plant, the estimated consequences of the accidents may be conservative because they are based on analyses of facilities that may not all meet the general design and safety requirements that will be implemented for new tritium supply facilities.

If the tritium supply facility is located at either INEL, NTS, ORR, or Pantex, the tritium recycling facility could be collocated be located at the same site. If the tritium supply facility is located at SRS, the existing tritium recycling facilities at SRS would be upgraded.

Both high consequence accidents and design basis/operational accidents are considered. High consequence accidents include accidents caused by natural phenomenon (i.e., earthquake, flood, tornado, tornado-driven debris, and high winds) in excess of the module design basis for safety systems. Operational accidents include fire, explosion, and spills. All upgraded or new tritium recycling facility safety-class structures and safety systems will be designed and installed to meet the design basis earthquake, flood, tornado, tornado driven debris, and wind natural phenomenon requirements.

**Scenario.** The postulated bounding high consequence accident is a beyond design basis earthquake that results in the spontaneous ignition of tritium released from ruptured reservoirs stored in the facility unloading station. The analysis postulated that the accident source term released to the environment during the accident is $8.4 \times 10^6$ Ci of tritium in oxide form. The accident annual frequency of occurrence at SRS is $2.0 \times 10^{-5}$ per year (DOE 1995g).

The accident annual frequency of occurrence for new tritium recycling facilities at the other candidate sites will be less than the frequency for existing facilities at SRS. It is assumed that the storage and confinement systems will be designed to maintain functional integrity following a design basis earthquake or a safe shutdown earthquake with a return frequency of $1.0 \times 10^{-4}$ per year. The evaluation also assumed that the storage and confinement systems may survive an earthquake with a return frequency of $1.0 \times 10^{-5}$ per year but catastrophic failure of the facility could be expected after an earthquake with a return frequency of $1.0 \times 10^{-6}$ per year. For the purpose of calculating the point estimate of risk for the postulated accident, the accident annual frequency of occurrence for all new facilities is assumed to be $1.0 \times 10^{-6}$ per year.

**Consequences.** The estimated consequences of the postulated high consequence accident for each of the four sites and for the SRS upgrade are shown in table F.2.3–1. Figure F.2.3–1 presents the cancer fatalities complementary cumulative distribution function. The dose and latent cancer fatality estimates were generated using the MACCS computer code and the postulated release of $8.4 \times 10^6$ Ci of tritium in the oxide form directly to the environment during the accident.

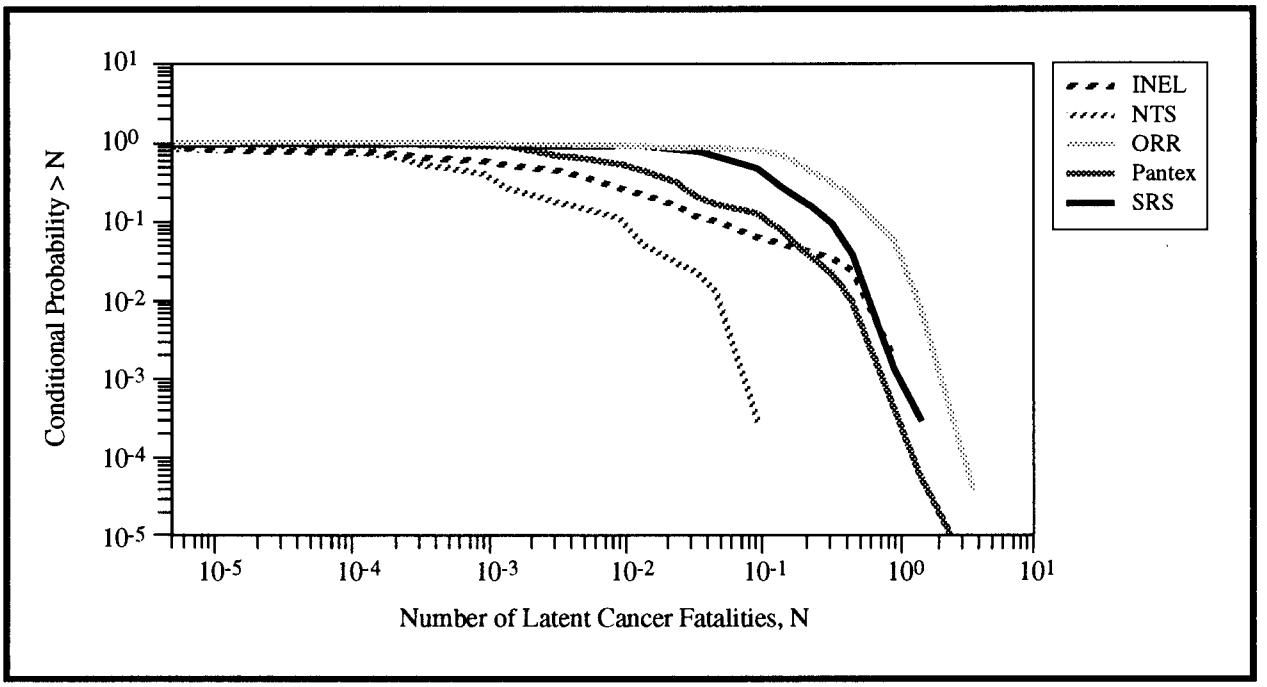


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**FIGURE F.2.3–1.**—***Tritium Recycling Facility High Consequence Accident–Cancer Fatalities Complementary Cumulative Distribution Function.***

**TABLE F.2.3–1.**—***Tritium Recycling Facility High Consequence Accident Consequence[a]***

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| **Site** | **Dose (rem)** | **Average Individual Risk of Cancer** | **Dose (person-rem)** | **Cancer Fatality** | **Accident Frequency (per year)** |
| INEL | 0.014 | $8.0 \times 10^{-7}$ | 81 | 0.041 | $1.0 \times 10^{-6}$ |
| NTS | 0.14 | $2.5 \times 10^{-6}$ | 8.2 | $4.1 \times 10^{-3}$ | $1.0 \times 10^{-6}$ |
| ORR | 1.0 | $2.4 \times 10^{-5}$ | 770 | 0.39 | $1.0 \times 10^{-6}$ |
| Pantex Plant | 0.63 | $1.5 \times 10^{-5}$ | 96 | 0.048 | $1.0 \times 10^{-6}$ |
| SRS[b] | 0.045 | $1.0 \times 10^{-6}$ | 300 | 0.15 | $2.0 \times 10^{-5}$ |

[a] Values shown are for inhalation and external doses only.

[b] Values shown are for the SRS tritium recycling facilities upgrade option.

### F.2.4 Tritium Recycling Facility Low to Moderate Consequence Accident

**Scenario.** The postulated bounding low to moderate consequence accident is the overheating and rupture of a hydride bed. Hydride beds are capable of being overheated to rupture due to equipment failures. Approximately 6,000 Ci of tritium in oxide form could be released to the environment. The accident annual frequency of occurrence is estimated at $2.0 \times 10^{-4}$ per year at SRS (DOE 1995g).

**Consequences.** The estimated consequences of the postulated hydride bed rupture accident for each of the four tritium supply technologies and recycling sites and for the SRS recycling facilities upgrade option are shown in tables F.2.4–1 and F.2.4–2 for 50 percent and 95 percent meteorology conditions. The estimates are based on the of the analysis of the postulated release of 6,000 Ci of tritium in oxide form directly to the environment during the accident using the GENII computer code.

TABLE F.2.4–1.—*Tritium Recycling Facility Hydride Bed Rupture Accident Consequence with 50 Percent Meteorology Conditions*[a]

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | $4.2 \times 10^{-4}$ | $2.1 \times 10^{-7}$ | 4.1 | $2.1 \times 10^{-3}$ | $2.0 \times 10^{-4}$ |
| NTS | $1.9 \times 10^{-4}$ | $9.5 \times 10^{-8}$ | 0.07 | $3.5 \times 10^{-5}$ | $2.0 \times 10^{-4}$ |
| ORR | $3.6 \times 10^{-3}$ | $1.8 \times 10^{-6}$ | 42 | 0.021 | $2.0 \times 10^{-4}$ |
| Pantex Plant | $3.3 \times 10^{-4}$ | $1.7 \times 10^{-7}$ | 1.4 | $7.0 \times 10^{-4}$ | $2.0 \times 10^{-4}$ |
| SRS[b] | $9.9 \times 10^{-4}$ | $4.9 \times 10^{-7}$ | 49 | 0.025 | $2.0 \times 10^{-4}$ |

[a] Values shown are for inhalation and external doses only.
[b] Values shown are for the SRS tritium recycling facilities upgrade.

TABLE F.2.4–2.—*Tritium Recycling Facility Hydride Bed Rupture Accident Consequence with 95 Percent Meteorology Conditions*[a]

| | Individual at Site Boundary | | Population to 50 Miles | | |
|---|---|---|---|---|---|
| Site | Dose (rem) | Cancer Fatality | Dose (person-rem) | Cancer Fatality | Accident Frequency (per year) |
| INEL | $1.5 \times 10^{-3}$ | $7.5 \times 10^{-7}$ | 25 | 0.013 | $2.0 \times 10^{-4}$ |
| NTS | $7.8 \times 10^{-3}$ | $3.9 \times 10^{-6}$ | 3.1 | $1.6 \times 10^{-3}$ | $2.0 \times 10^{-4}$ |
| ORR | 0.03 | $1.5 \times 10^{-5}$ | 250 | 0.13 | $2.0 \times 10^{-4}$ |
| Pantex Plant | 0.02 | $1.0 \times 10^{-5}$ | 110 | 0.055 | $2.0 \times 10^{-4}$ |
| SRS[b] | 0.019 | $9.5 \times 10^{-6}$ | $1.1 \times 10^{3}$ | 0.55 | $2.0 \times 10^{-4}$ |

[a] Values shown are for inhalation and external doses only.
[b] Values shown are for the SRS tritium recycling facilities upgrade.

## F.3 SECONDARY IMPACTS OF ACCIDENTS

The primary impacts of accidents are measured in terms of public and worker exposures to radiation and toxic chemicals. The secondary impacts of accidents affect elements of the environment other than humans. For example, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be lowered; recreational areas may be closed; industrial parks may suffer economic losses during shutdown for decontamination; historical sites may have to be closed to visitors; and the endangered species may move closer to extinction.

This section addresses the secondary impacts of a reactor charge/discharge design basis accident in the region of a radiological release. This accident was selected as representative of a design basis accident although another accident for any other technology could also have been selected to illustrate the secondary effects. Other design basis accidents with greater source terms could also be found that would show secondary effects extending over a larger region than shown in figures F.3.1–1 through F.3.5–1. The source term for the HWR charge/discharge accident is shown in table F.2.2.1–1. The level of exposure estimates are based on analysis of the source term in table F.2.2.1–1 using the GENII computer code with 50 percent meteorology conditions for each site.

The region of secondary effects extends out from the point of release in a pattern formed by dispersion parameters such as meteorology. The level of exposure is generally decreasing with increasing distance from the release point. Figures F.3.1–1 through F.3.5–1 show the shapes of patterns for each site at a distance at which the level of exposure from the accidental release would be equivalent to the level of annual exposure from natural background radiation at each site. Levels of exposure that are less than natural background can be expected in areas outside of the shaded pattern.

These results are useful for comparing the sensitivity of sites with respect to the secondary impacts for an accidental radiological release from a reactor. In reviewing the results, it is useful to note whether the impacted area extends beyond the site boundary where the economic impacts would be larger than if the area were contained within the site boundary. It is also useful to note the size of the contaminated area in which the level of exposure exceeds exposures from natural background.

### F.3.1 Idaho National Engineering Laboratory

In the region of the INEL, the natural background level of radiation (excluding radon) is 113 mrem per year. The results shown in figure F.3.1–1 indicate that, for an accidental release, the radiation levels exceeding 113 mrem per year (shaded area bounded by a bold line) are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $6.7 \times 10^7$ square meters (16,556 acres). Section 4.2 describes the land, water, biotic, cultural, paleontological and socioeconomic resources in the INEL environment that may receive secondary impacts from a design basis accident.

### F.3.2 Nevada Test Site

In the region of the NTS, the natural background level of radiation (excluding radon) is 78 mrem per year. The results shown in figure F.3.2–1 indicate that, for an accidental release, the radiation levels exceeding 78 mrem per year (shaded area bounded by a bold line) are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $9.1 \times 10^5$ square meters (225 acres). Section 4.3 describes the land, water, biotic, cultural, paleontological and socioeconomic resources in the NTS environment that may receive secondary impacts from a design basis accident.

### F.3.3 Oak Ridge Reservation

In the region of the ORR, the natural background level of radiation (excluding radon) is 67 mrem per year. The results shown in figure F.3.3–1 indicate that, for an accidental release, the radiation levels exceeding 67 mrem per year (shaded area bounded by a bold line) are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $1.4 \times 10^7$ square meters (3,459 acres). Section 4.4

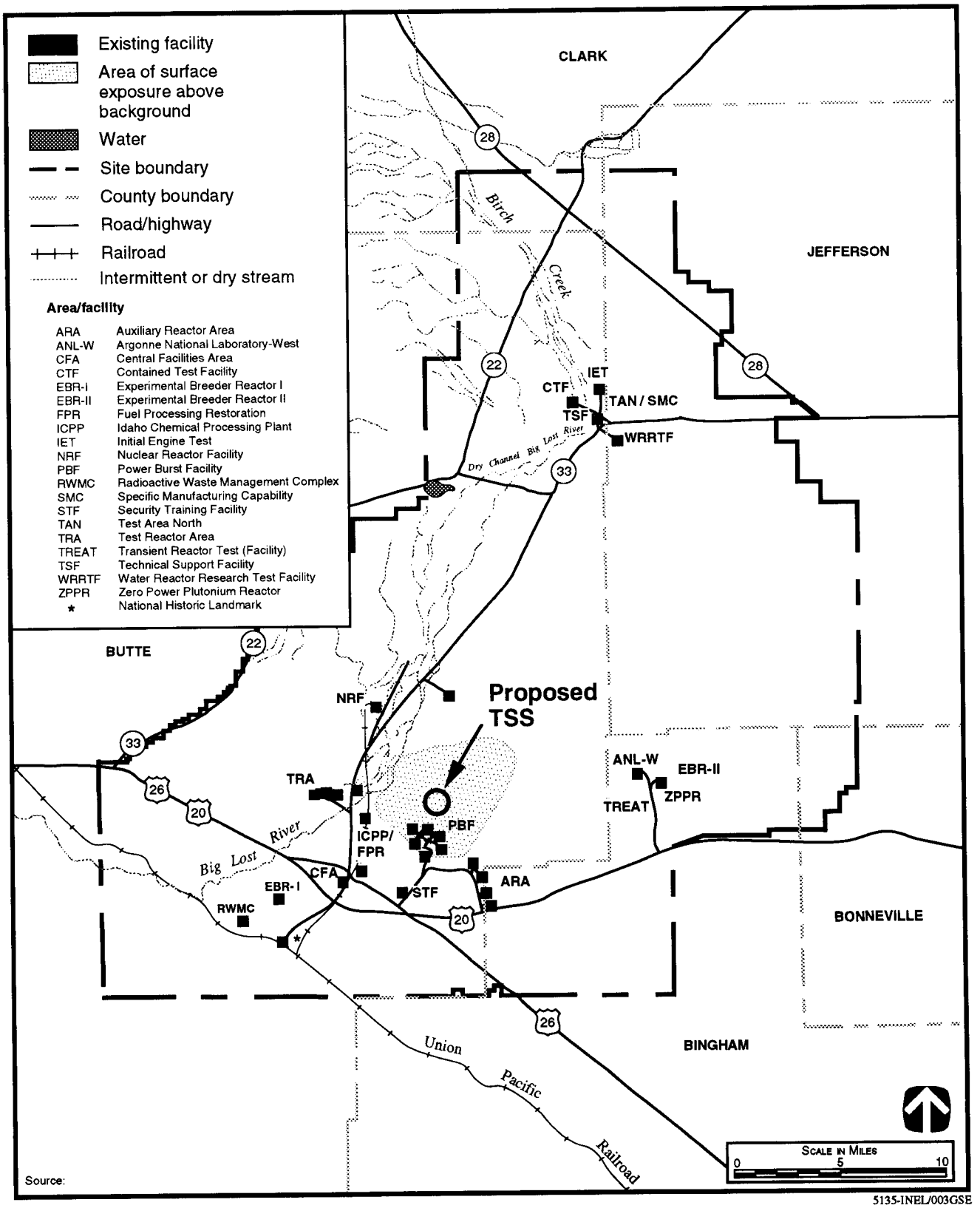
describes the land, water, biotic, cultural, paleontological and socioeconomic resources in the ORR environment that may receive secondary impacts from a design basis accident.

### F.3.4 Pantex Plant

In the region of Pantex, the natural background level of radiation (excluding radon) is 107 mrem per year. The results shown in figure F.3.4–1 indicate that, for an accidental release, the radiation levels exceeding 107 mrem per year (shaded area bounded by a bold line) extend beyond the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $9.3 \times 10^7$ square meters (22,980 acres). Section 4.5 describes the land, water, biotic, cultural, paleontological and socioeconomic resources in the Pantex environment that may receive secondary impacts from a design basis accident.

### F.3.5 Savannah River Site

In the region of the SRS, the natural background level of radiation (excluding radon) is 76 mrem per year. The results shown in figure F.3.5–1 indicate that, for an accidental release, the radiation levels exceeding 76 mrem per year (shaded area bounded by a bold line) are well within the site boundary. The size of the area in which exposure levels would exceed exposures from natural background radiation is $2.9 \times 10^7$ square meters (7,166 acres). Section 4.6 describes the land, water, biotic, cultural, paleontological and socioeconomic resources in the SRS environment that may receive secondary impacts from a design basis accident.




5135-INEL/003GSE

**FIGURE F.3.1–1.**—*Design Basis Accident for Typical Reactor at Idaho National Engineering Laboratory (ground surface exposure–113 mrem/yr).*

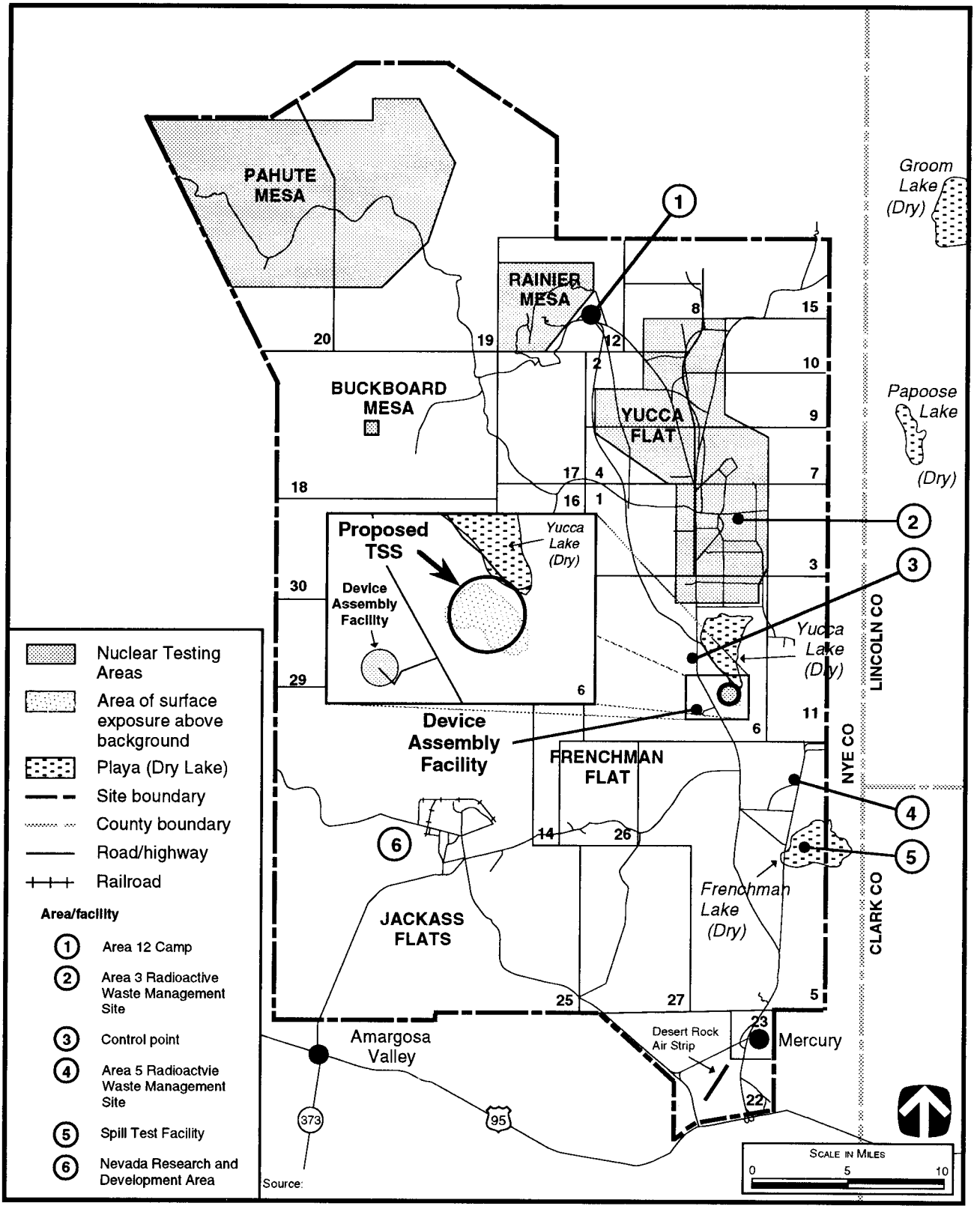



**FIGURE F.3.2–1.**—*Design Basis Accident for Typical Reactor at Nevada Test Site (ground surface exposure–78 mrem/yr).*

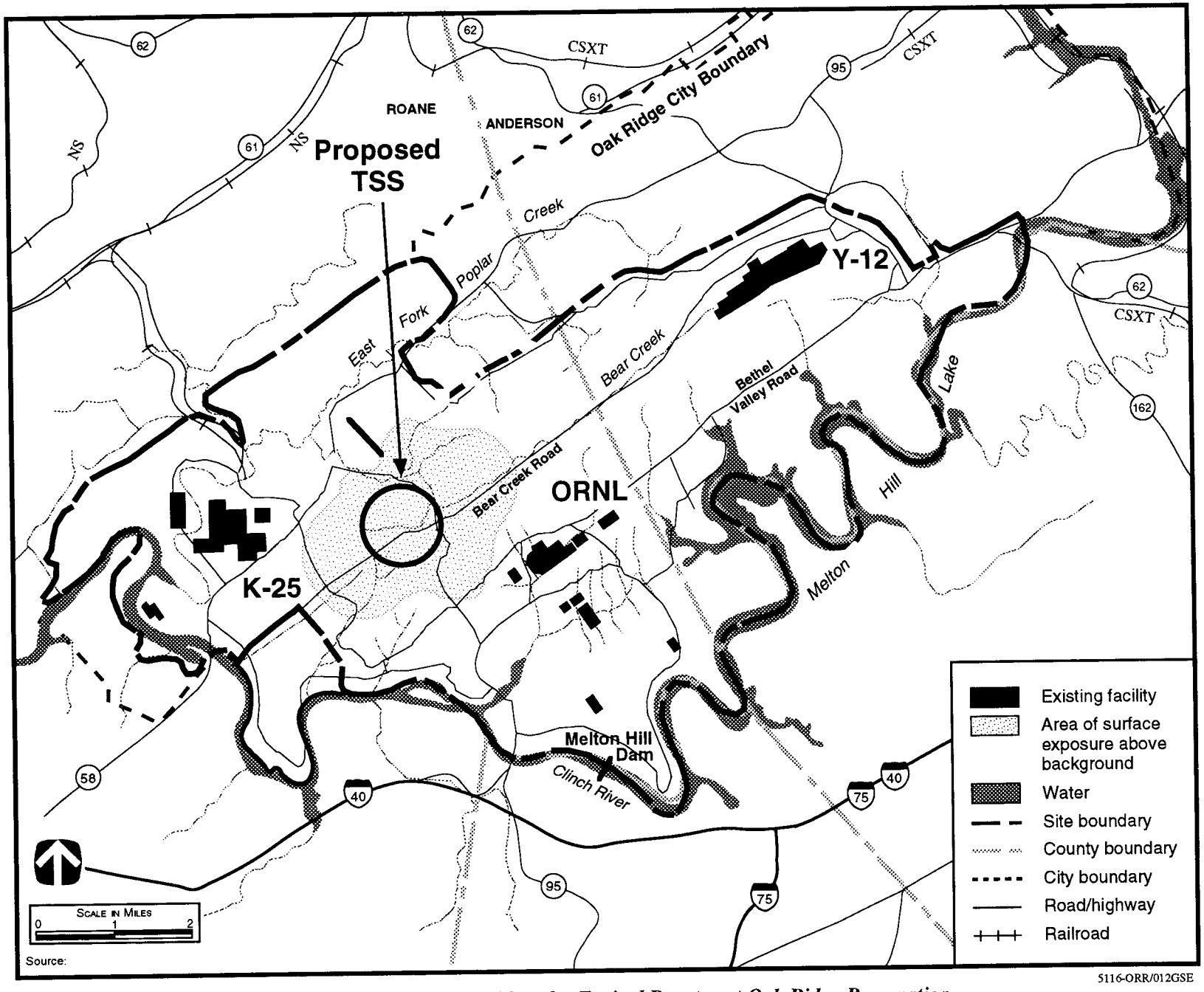
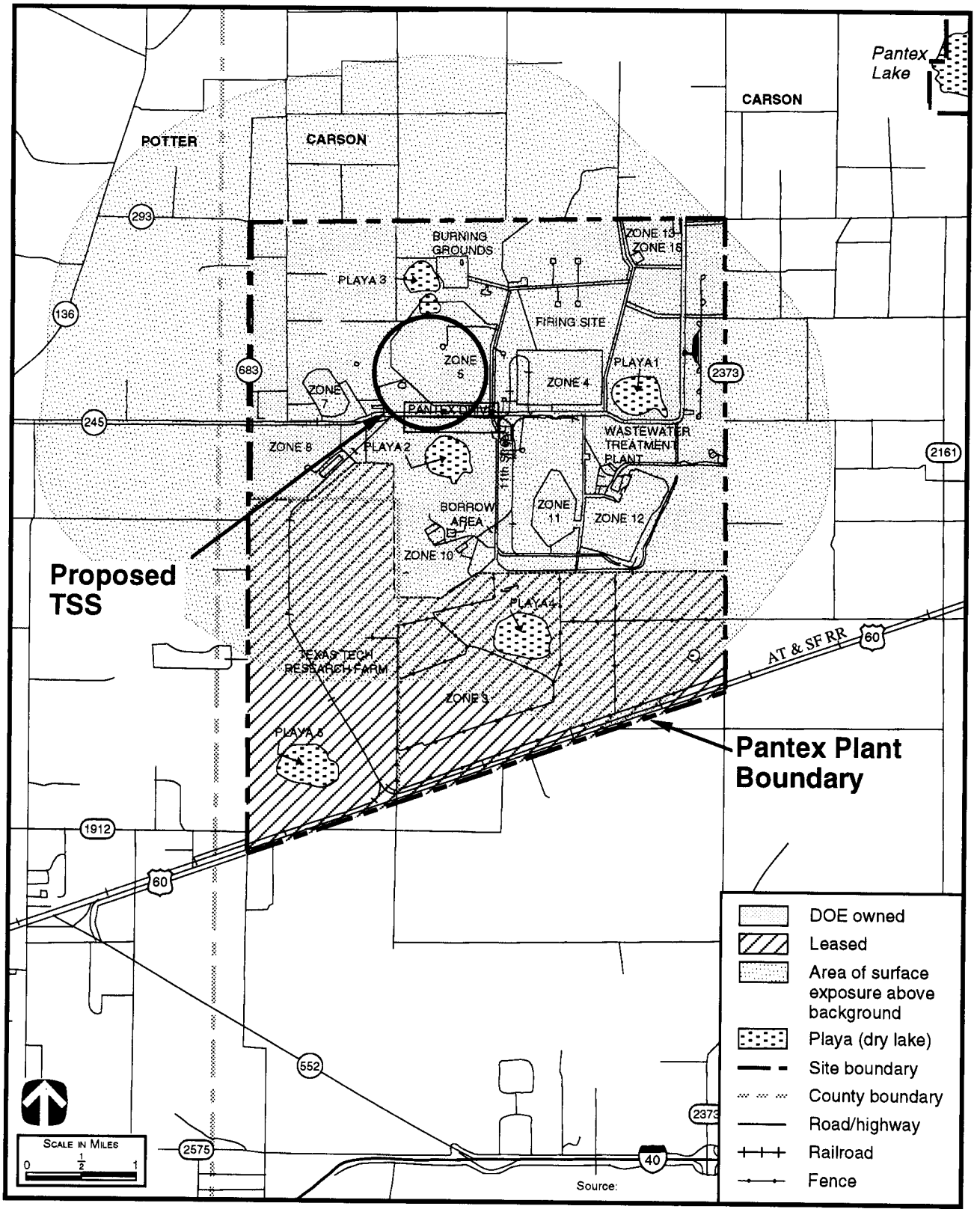



FIGURE F.3.3–1.—*Design Basis Accident for Typical Reactor at Oak Ridge Reservation (ground surface exposure–67 mrem/yr).*




5085-PAN/002GSE

**FIGURE F.3.4–1.**—*Design Basis Accident for Typical Reactor at Pantex Plant, Texas (ground surface exposure–107 mrem/yr).*

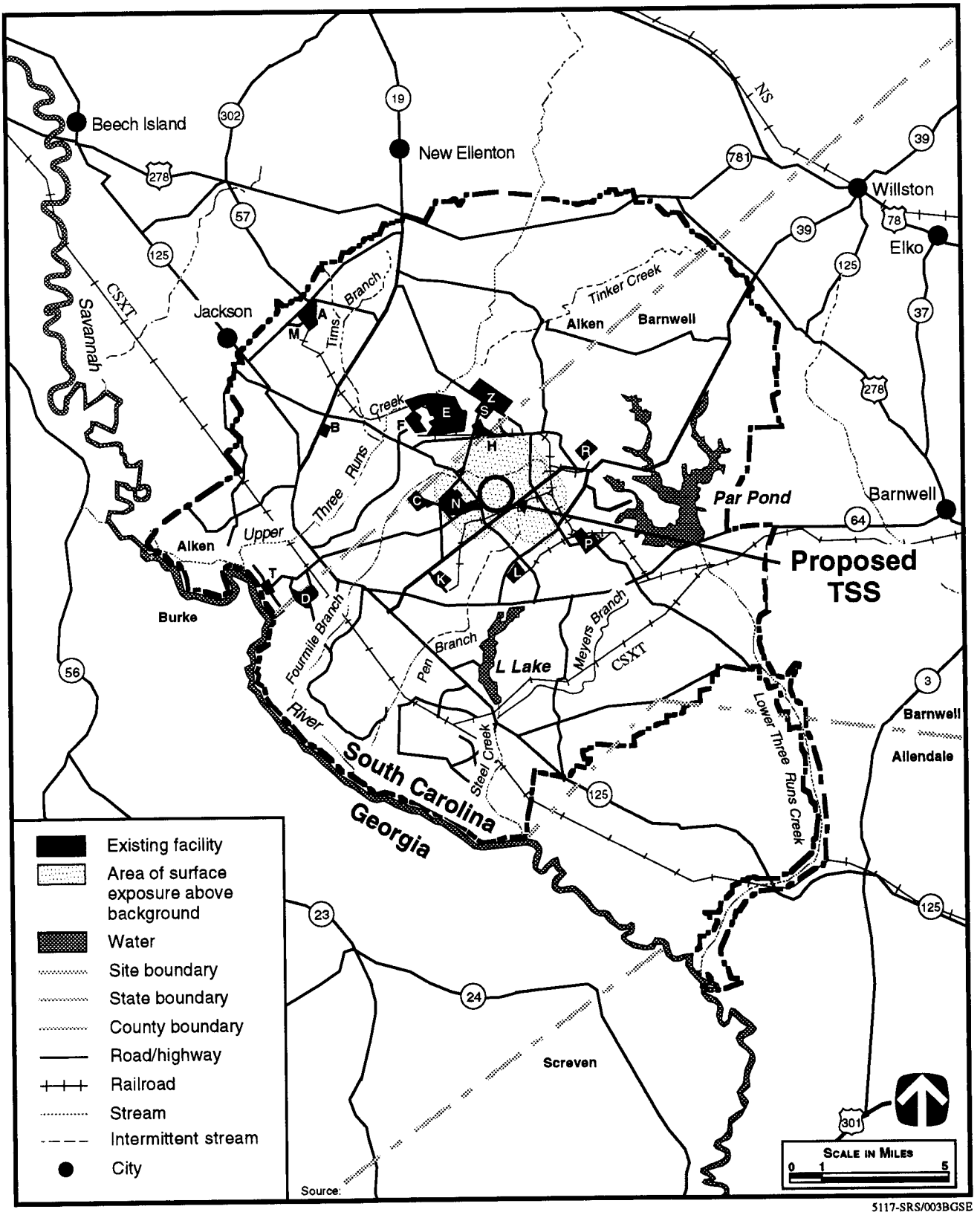



**FIGURE F.3.5–1.**—*Design Basis Accident for Typical Reactor at Savannah River Site (ground surface exposure–76 mrem/yr).*

# APPENDIX G

# Appendix G

# APPENDIX G: INTERSITE TRANSPORTATION

## G.1 Site Transportation Interfaces for Hazardous Materials

The following is a brief description of the existing transportation modes that serve each Nuclear Weapons Complex (Complex) site and the links to those modes for the intersite transport of hazardous materials. The purpose of this analysis is to identify transportation constraints at each site that might limit tritium supply and recycling alternatives.

Transportation services at each site have been given an adjectival rating based on strengths and weaknesses. These ratings are: outstanding, good, satisfactory, poor, or unsatisfactory. The rating methodology and evaluation procedures were established by the Nuclear Weapons Complex Reconfiguration Site Evaluation Panel (DOE 1991j) for rating the Idaho National Engineering Laboratory (INEL), Oak Ridge Reservation (ORR), Pantex Plant (Pantex), and Savannah River Site (SRS). For consistency, the methodology was applied for the Nevada Test Site (NTS) as well.

**Idaho National Engineering Laboratory**. INEL transportation resources are good but would require additional roadway and railway construction. The northern route would cause delays of special nuclear material shipments due to winter ice and snow. The onsite rail system connects to the Union Pacific Railroad. Due to lack of volume, service is infrequent and by special request only, due to lack of volume. Construction of an additional 7.5 miles of new rail spur would be needed for direct rail service to the proposed tritium supply site (TSS). The nearest interstate highway is approximately 46 miles from the proposed TSS via 40 miles of excellent 2-lane road; however, approximately 6 miles of new connector road would need to be constructed to reach the site. The airport in Idaho Falls is 40 miles from the site.

**Nevada Test Site**. NTS transportation resources are good. The nearest interstate highway, I-15, is approximately 60 miles from the site via 4-lane divided blacktop U.S. highway. The site does not have direct rail access. The nearest railhead is at Las Vegas, approximately 65 miles south, which is served by the Union Pacific Railroad. There are no navigable waterways in the region. All air shipments arrive at McCarran International Airport at Las Vegas. There is a limited-access air strip on the site at Desert Rock; however, nearby Indian Springs would be used by Ross Aviation because of available aircraft servicing support. The site reports no significant transportation delays due to weather (NTS 1992a:3).

**Oak Ridge Reservation**. ORR transportation resources are good, with minimal additional roadway and railway construction required. ORR has the advantage of southern routes, with minimal expected weather delays. The proposed TSS is approximately 2 miles from the ORR spur, which connects to the Norfolk Southern Railroad, and 4.6 miles from the Y-12 Plant (Y-12) spur that connects to the CSX Railroad. The nearest interstate highway is 4 miles away via good 2-lane road. A regional airport in Knoxville, TN, is approximately 31 miles from the site. The airport is served by nine airlines and has adequate services, including a dedicated Ross Aviation loading and unloading facility. Barge shipments are possible using the Clinch River. A disadvantage is that routes to the Waste Isolation Pilot Plant (WIPP), Pantex, and NTS pass through or close to 6 to 9 large metropolitan areas.

**Pantex Plant**. Pantex transportation resources are outstanding. The site rail spur connects to the Burlington Northern and the Santa Fe Railroads. The Department of Energy (DOE) has a rail rolling stock repair capability on this site. Truck routes have the advantages of being southerly and of passing through or near only 2 or 3 metropolitan areas en route to nearby DOE sites (e.g., WIPP or NTS). The Transportation Safeguards Division terminal with diesel and truck maintenance facility is located at Pantex. The nearest interstate highway is accessed via 7 miles of 2-lane road. The Amarillo International Airport is 20 miles from the site and is served by 5 airlines.

**Savannah River Site**. SRS transportation resources are good. Routes to WIPP and NTS have the advantage of being southerly and the disadvantage of

passing through 6 to 9 major metropolitan areas, including local business districts. The proposed TSS is approximately 1.5 miles from the site rail system that connects to the CSX and the Norfolk Southern Railroads. Barge shipments are possible, but normally impractical due to the shallow depth of the Savannah River. The water mode will require prior review of river depths and coordination with the U.S. Army Corps of Engineers for water releases from the lock and dam. SRS has a dock. The nearest interstate highway is 30 miles away via predominately 4-lane access road. Two regional airports are located in Augusta, GA, 20 miles away, and in Columbia, SC, 56 miles from the site. Both air fields can handle large aircraft. There are occasional landing and takeoff delays of 2 or 3 hours due to fog.

## G.2 Transportation Safety Studies

The Office of the Assistant Secretary for Defense Programs (DP) is undertaking a program to provide the basis for a documented DOE acceptance of hazards and risks associated with future defense program transportation operations. This program will be accomplished by preparing specialized studies and integrating the findings in a *Defense Programs Transportation Safety Analysis Report.* The specialized studies are as follows:

- The Albuquerque Operations Office studied the accident risk in the transport of nuclear weapons, nuclear weapons components, and special nuclear material in DOE/DP's transportation system. The study produced a probabilistic assessment of the risks associated with accidental dispersal of radioactive material being transported by DOE's Transportation Safeguards System; by DOE's air cargo contractor, Ross Aviation, Inc.; or by military airlift. The Albuquerque Operations Office assessment shows that the probability of an accident by Ross Aviation is $2.7 \times 10^{-4}$ per year. The assessment also shows that the annual tritium release probability for Ross Aviation is $1.0 \times 10^{-5}$ and the health risk from the accidental release of tritium is $9.0 \times 10^{-8}$ latent cancer fatalities per year. A more detailed discussion of the assessment is included in the Classified Appendix of this *Programmatic Environmental Impact Statement* (PEIS).

- DOE is evaluating the results of accident-environment testing performed on the safe secure trailers to demonstrate the crashworthiness of the design, and the results will be incorporated into the Defense Programs Transportation Risk Assessment. The DOE historical safety record of the safe secure trailer has been exceptionally good. There has not been an accident fatality or release of radioactive material in over 27 million miles travelled.

- DOE evaluated air transport: (1) operations, aircraft, hazardous material/cargo management, and packaging; (2) operational safety requirements; (3) aircraft maintenance and quality assurance; (4) emergency response; (5) personnel training; and (6) environmental safety and health management practices. The accident risk for Ross Aviation was estimated using National Transportation Safety Board accident fatality data for commercial aircraft operations in accordance with 14 CFR 121, 125, and 127. The Ross Aviation accident probability is $2.70 \times 10^{-4}$ per year and is documented in the Defense Programs Transportation Risk Assessment (DOE 1993n:5).

The *Defense Programs Transportation Safety Analysis Report* will also consider other transportation risk studies, such as the ongoing Department of Defense (DOD) and DOE's *Study on the Logistical Transportation of Nuclear Weapons*, which evaluates the transport of weapons to and from DOD sites.

## G.3 Hazardous Materials Packaging (Materials Containment)

Hazardous materials are those substances or materials capable of posing an unreasonable risk to health, safety, and property. To protect the public health and safety, packaging must be selected based upon the nature of the hazardous material being shipped. All hazardous materials transported by or for the DOE must meet the packaging (containment)

requirements prescribed by the Department of Transportation (DOT) under 49 CFR and other applicable Federal regulations.

For purposes here, hazardous materials are characterized as either common or Complex-unique. Common hazardous materials are those transported in commerce by for-hire transportation carriers. Approximately 96 percent of the Complex's hazardous material shipments are transported this way.

Complex-unique hazardous materials are radioactive special materials that include limited-life components (e.g., tritium reservoirs). Complex-unique hazardous materials are produced by DOE and require special physical protection (safeguards) in transit for safety and security. Complex-unique hazardous materials are transported by government-controlled vehicles. The packagings for both common and Complex-unique hazardous materials are explained below.

### G.3.1 Packaging for Common Hazardous Materials

Packaging used by DOE for most hazardous materials shipments is either certified to meet specific performance requirements or built to specifications described in the DOT hazardous materials regulations (49 CFR). Most hazardous materials may be transported in relatively simple, unsophisticated 55-gallon or smaller steel drums, cardboard or wooden boxes, gas cylinders, and cargo tanks. For less harmful radioactive materials, DOT Specification Type A packaging is used. These packagings must retain their contents under normal conditions of transport.

Sensitive radioactive materials shipments require use of highly sophisticated Type B packaging, designed to prevent the release of contents under all credible transportation accident conditions. Though packaging and transportation are regulated by the DOT under 49 CFR, the Nuclear Regulatory Commission (NRC) promulgates the standards and regulations for the packagings used to transport highly radioactive and fissile materials under 10 CFR 71. Federal certification for these packaging types can take up to 5 years and cost over $1 million for each packaging design due to the severe testing conditions required.

Hazardous radioactive materials such as solidified high-level waste (HLW) and spent nuclear fuel must be packaged and transported in heavily shielded, virtually indestructible shipping casks in accordance with 10 CFR 71. Cold (unirradiated) fuel packagings also must meet 10 CFR 71 regulations. Packagings must retain their contents under credible accident conditions. There has not been a significant release of material under normal or accident transport environments in more than 40 years.

### G.3.2 Packaging for Limited-Life Components

In addition to meeting the stringent Type B containment and confinement requirements of NRC's 10 CFR 71 and DOT's 49 CFR, packaging for nuclear weapons and components, including tritium reservoirs, must be certified separately by DOE. Limited-life components must be transported in the DOE's closed, government-owned and operated Transportation Safeguards System for intersite transport. Contract air carrier (Ross Aviation), military airlift, and specially designed safe secure trailers are utilized to ensure high levels of safety and physical protection. Limited-life components are shipped in H1616 type packaging designed to contain the material and radiation in an accident.

## G.4 Transportation of Radioactive Waste

DOE's spent nuclear fuel and HLW produced by defense program activities are currently stored at reactor or DOE sites. The safe and permanent disposal of this nuclear waste, including its transportation, is the responsibility of DOE.

The *Nuclear Waste Policy Amendments Act* of 1987 specified that Yucca Mountain, NV, will be the one site evaluated as a permanent repository. Legislation prohibits the shipment of defense spent nuclear fuel to the first repository; however, HLW from defense program activities may be shipped to the first repository.

DOE has future plans to move the spent nuclear fuel to a monitored retrievable storage facility for temporary storage, where the material will be consolidated and prepared for further transport and final

storage at a permanent repository. DOE expected the monitored retrievable storage facility to be operational by 1998; however, a monitored retrievable storage facility site has yet to be selected. By law, the monitored retrievable storage facility cannot handle or store military waste and can store commercial spent fuel only temporarily. If a monitored retrievable storage facility is licensed and becomes operational, spent nuclear fuel will be transported by truck, rail, barge, or a combination of these modes to the monitored retrievable storage facility. After consolidation at the monitored retrievable storage facility, the spent nuclear fuel would be shipped in dedicated trains to the repository. A 100-ton gross weight NRC-approved cask is being developed for the rail transportation of this spent nuclear fuel to the repository. Defense HLW would be shipped directly to the repository, mainly by rail from the DOE sites where it is stored.

The tritium supply and recycling functions do not generate transuranic (TRU) waste. TRU waste, however, is generated at the proposed sites from unrelated activities. The following is a summary of the planned disposal for TRU waste. The WIPP, 26 miles from Carlsbad, NM, is scheduled to be the Nation's first geologic repository for TRU waste. Base facility construction was completed in 1989, but use is being delayed to satisfy legal, technical, environmental, and logistical requirements. DOE ultimately hopes to ship 8,500 drums of TRU waste to WIPP. Ninety-seven percent of the waste scheduled for WIPP will be contact-handled TRU waste that can be safely handled by workers without special protective clothing. Contact-handled TRU waste will be shipped via trucks in Transuranic Packaging Transporters, canisters designed to hold fourteen 55-gallon drums. Remote-handled TRU waste is to be handled and transported in specially shielded containers because of its higher level of radioactivity. No remote-handled TRU waste will be emplaced at the WIPP during the initial 5-year test phase.

Radioactive low-level waste (LLW) results from industrial processes and includes radioactively contaminated paper, protective clothing, cleaning materials, metal and glass equipment, tools, and construction items. The Complex's LLW is disposed of at permitted onsite locations with the exception of Pantex, which ships LLW to NTS. Waste that is equivalent to NRC-designated Greater-Than-Class-C LLW has a higher concentration of radionuclides and is generally not acceptable for near-surface disposal. DOE has developed a long-range strategy to dispose of Greater-Than-Class-C LLW either in conjunction with a HLW repository or in a separate facility.

Mixed waste contains both radioactive and other hazardous components. Mixed HLW will be placed in a repository, mixed TRU waste will be shipped to WIPP, and mixed LLW will be held onsite or shipped to NTS after approval of its pending permit.

## G.5 Methodology to Determine Risk of Transporting Low-Level Waste

With the exception of Pantex, all sites being considered for the tritium supply and recycling facilities either have or have planned an onsite LLW disposal facility. The incremental increase in risk of transporting LLW from Pantex as a result of locating tritium supply and recycling facilities at Pantex was estimated. The waste type reflects the isotopic composition of LLW produced by tritium supply and recycling facilities. The isotopic composition was developed based upon information in the *Integrated Data Base for 1992: U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics* (DOE/RW-0006). Because the actual waste composition in the future is uncertain, conservative assumptions were used where appropriate.

Argonne National Laboratory-West calculated the risks of transporting LLW from Pantex to NTS using the RADTRAN 4 computer code (PX DOE 1993a:1). This risk analysis model was developed by Sandia National Laboratories, New Mexico, to calculate the risks associated with the transportation of radioactive materials by various modes. The code has been extensively updated since it was first issued in the late 1970's and has been used to assess risk for all recent DOE *National Environmental Policy Act* (NEPA) documents involving the transport of radioactive materials. The *RADTRAN 4: Volume 3 User Guide* (SAND89-2370) contains derivations of the model, assumptions, and other data necessary to use the code.

All LLW would be transported from Pantex to NTS in a solid form. A typical shipment consists of eighty 55-gallon (208 liter) drums transported in an enclosed semitrailer. Each drum is assumed to be

fully loaded, resulting in a total shipment volume of 21.7 cubic yards ($yd^3$). The truck is assumed to operate as an "exclusive-use" vehicle. Risks were calculated separately for occupational (truck crew members) and nonoccupational exposure groups for normal (incident-free) conditions. Normal risk is directly proportional to the external exposure rate in the vicinity of a loaded shipment. For exclusive-use shipments, the dose rate may not exceed 2 millirem (mrem) per hour in the crew compartment and 10 mrem per hour at 2 meters from the lateral surfaces of the conveyance, in accordance with 10 CFR 71. In general, the dose rate measured 2 meters from a typical LLW shipment is on the order of 1 mrem per hour or less and seldom reaches the 10 mrem per hour regulatory limit (PX DOE 1993a:1). Since tritium LLW is a low-energy beta emitter that is shielded by its packaging, radiation outside the package is not detectable. Therefore, for normal operations, the transport of tritium LLW poses no increased risk to transportation workers or to the public.

The risk from accident conditions results from the release and dispersal of radioactive material to the environment following an accident and the subsequent exposure of people via a number of potential pathways. Because accident occurrences are infrequent and statistical in nature, accident risks are calculated by multiplying the consequences of an accident by the probability of the accident occurring. Accident risk estimates can thus be directly compared to incident-free risks. A representative highway route from Pantex to NTS was calculated using the HIGHWAY computer code. The calculated route conforms to all applicable routing regulations and common practices but may not be the actual route used for LLW shipments. The representative route is 1,200 miles. Accident occurrence and fatality rates were determined using state-level and national statistics. The severity categories for the release of radioactive material during accidents are described in the NRC's regulation, *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes* (NUREG-0170). As a conservative measure, all 80 drums were assumed to be equally breached during an accident of sufficient severity. For a given release, 10 percent of the radioactive inventory was assumed to become aerosolized and dispersed, with 5 percent of the aerosolized fraction being respirable. Tritium is shipped in solid form, but could become vaporized in an accident. For tritium, 100 percent of the release was assumed to be respirable (PX DOE 1993a:1).

The *1990 Recommendations of the International Commission on Radiological Protection* (ICRP Publication 60) provides health risk factors to convert dose rates to fatal cancers (PX DOE 1993a:1). For occupational exposure groups, the conversion factor is $4.0 \times 10^{-4}$ fatal cancers per person-rem and for nonoccupational exposure groups the conversion is $5.0 \times 10^{-4}$ fatal cancers per person-rem.

The following formulas were used to estimate the accident-related health risk of transporting tritium LLW from Pantex to NTS.

(a) Effects of radiological release from an accident:

Latent cancer fatalities per year = $6.5 \times 10^{-7}$ person-rem per shipment x $5.0 \times 10^{-4}$ cancers per person-rem x number of shipments per year

(b) Effects of nonradiological accident:

Traffic fatalities per year = $4.3 \times 10^{-6}$ fatalities per shipment x number of shipments per year

## G.6 Supporting Transportation Data

Table G.6–1 provides a 5-year summary of the nonhazardous and hazardous cargo shipped by commercial carrier to and from each of the five proposed tritium supply and recycling sites from 1987 through 1991. For the entire Complex, cargo traffic by weight decreased approximately 15 percent per year during this period. Table G.6–1 shows that traffic in 1991 for the sites examined was down 57 percent from 1987 traffic, or about the same annual percentage decline experienced by the Complex as a whole.

Table G.6–2 lists all of the hazardous material shipments by chemical for 1991, for the five proposed tritium supply and recycling sites. All of these shipments were by commercial carriage.

Table G.6–3 gives air distances between selected sites. These distances are those usually travelled when transporting limited-life components by Ross Aviation.

TABLE G.6–1.—*Five-Year Summary of Traffic To/From Proposed Tritium Supply and Recycling Sites*[a]

| Site | 1987 | | 1988 | | 1989 | | 1990 | | 1991 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) |
| **Idaho National Engineering Laboratory** | | | | | | | | | | |
| Nonhazardous | 19,239 | 42,898,007 | 20,815 | 44,405,718 | 23,062 | 20,088,963 | 26,075 | 12,803,235 | 29,999 | 11,615,910 |
| Hazardous | 1,849 | 46,575,944 | 2,321 | 66,214,775 | 1,879 | 51,740,159 | 1,455 | 43,140,437 | 1,542 | 51,584,218 |
| All cargo | 21,088 | 89,473,951 | 23,136 | 110,620,493 | 24,941 | 71,829,122 | 27,530 | 55,943,672 | 31,541 | 63,200,128 |
| **Nevada Test Site** | | | | | | | | | | |
| Nonhazardous | 21,967 | 131,434,065 | 24,055 | 106,140,873 | 26,248 | 140,037,819 | 23,077 | 84,782,403 | 21,875 | 79,756,555 |
| Hazardous | 2,381 | 59,344,141 | 2,389 | 66,842,376 | 2,501 | 69,578,710 | 1,722 | 45,471,622 | 1,304 | 34,782,556 |
| All cargo | 24,348 | 190,778,206 | 26,444 | 172,983,249 | 28,749 | 209,616,529 | 24,799 | 130,254,025 | 23,179 | 114,539,111 |
| **Oak Ridge Reservation** | | | | | | | | | | |
| Nonhazardous | 37,872 | 25,120,900 | 39,578 | 25,230,131 | 36,609 | 20,043,727 | 38,009 | 16,573,098 | 38,922 | 14,738,586 |
| Hazardous | 3,206 | 16,124,730 | 3,070 | 11,895,666 | 2,531 | 9,108,989 | 1,878 | 6,530,250 | 1,281 | 4,419,765 |
| All cargo | 41,078 | 41,245,630 | 42,648 | 37,125,797 | 39,140 | 29,152,716 | 39,887 | 23,103,348 | 40,203 | 19,158,351 |
| **Pantex Plant** | | | | | | | | | | |
| Nonhazardous | 7,739 | 3,547,477 | 8,140 | 3,257,166 | 7,676 | 3,309,524 | 8,268 | 2,867,899 | 9,772 | 3,156,359 |
| Hazardous | 1,802 | 1,076,257 | 1,659 | 1,135,110 | 1,589 | 1,018,242 | 1,768 | 814,347 | 1,273 | 763,083 |
| All cargo | 9,514 | 4,623,734 | 9,799 | 4,392,276 | 9,265 | 4,327,766 | 10,036 | 3,682,246 | 11,045 | 3,919,442 |
| **Savannah River Site** | | | | | | | | | | |
| Nonhazardous | 14,249 | 871,069,675 | 16,309 | 870,424,143 | 21,192 | 512,795,471 | 35,415 | 501,730,778 | 33,484 | 315,737,363 |
| Hazardous | 397 | 9,564,842 | 534 | 12,044,143 | 537 | 10,180,879 | 852 | 8,778,981 | 562 | 8,205,286 |
| All cargo | 14,646 | 880,634,517 | 16,843 | 882,468,286 | 21,729 | 522,976,350 | 36,267 | 510,509,759 | 34,046 | 323,942,649 |

[a] Includes both Complex and other DOE commercial shipments to and from these locations, including shipments to and from non-DOE activities. It does not include DOE-controlled classified shipments.

Source: SAIC 1992a:3; SAIC 1992a:5.

TABLE G.6–2.—*Hazardous Materials Shipments for Proposed Tritium Supply Technologies and Recycling Sites, 1991*[a] [Page 1 of 3]

| Commodity | INEL | | NTS | | ORR | | Pantex | | SRS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) |
| Acetylene gas | 0 | 0 | 2 | 840 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aluminum sulfate, solid | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 50,800 |
| Ammonia hydroxide | 0 | 0 | 3 | 108 | 1 | 496 | 0 | 0 | 0 | 0 |
| Ammonia, anhydrous | 5 | 3,005 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ammonium fluoride | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Argon | 2 | 14,561 | 4 | 1,750 | 0 | 0 | 2 | 11,640 | 2 | 810 |
| Asbestos articles | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 505 |
| Asphalt | 0 | 0 | 7 | 182,660 | 2 | 3,244 | 0 | 0 | 1 | 900 |
| Beryllium metal | 3 | 74 | 0 | 0 | 14 | 32,338 | 0 | 0 | 0 | 0 |
| Blasting agents | 1 | 150 | 0 | 0 | 0 | 0 | 4 | 278 | 0 | 0 |
| Cadmium nitrate | 0 | 0 | 0 | 0 | 2 | 1,386 | 0 | 0 | 0 | 0 |
| Cadmium sulfate | 1 | 125 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Calcium nitrate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| Chlorine | 4 | 1,500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Class A explosives, NOS | 1 | 225 | 3 | 5,403 | 2 | 1,214 | 69 | 26,684 | 0 | 0 |
| Class A poison | 1 | 530 | 1 | 132 | 1 | 2 | 1 | 18 | 4 | 215 |
| Class B explosives, NOS | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 3,384 | 0 | 0 |
| Class B poison | 5 | 137 | 6 | 594 | 6 | 1,849 | 3 | 706 | 4 | 136 |
| Class C explosives, NOS | 7 | 297 | 3 | 531 | 3 | 62 | 550 | 74,288 | 16 | 6,583 |
| Combustible liquid, NOS | 9 | 143,696 | 26 | 313,837 | 2 | 1,759 | 0 | 0 | 10 | 7,397 |
| Corrosive material, NOS | 92 | 693,757 | 94 | 220,153 | 126 | 562, 948 | 39 | 30,137 | 73 | 155,530 |
| Dry ice | 0 | 0 | 0 | 0 | 15 | 228 | 0 | 0 | 0 | 0 |
| Empty hazmat containers, non-RAM | 1 | 37,000 | 82 | 692,937 | 28 | 53,218 | 1 | 6,000 | 4 | 24,450 |
| Ferrous sulfate | 0 | 0 | 0 | 0 | 1 | 2,804 | 0 | 0 | 0 | 0 |
| Flammable gas, NOS | 23 | 137,556 | 26 | 105,297 | 27 | 20,473 | 6 | 697 | 7 | 5,279 |
| Flammable liquid, NOS | 45 | 479,105 | 106 | 84,386 | 88 | 91,163 | 35 | 10,497 | 106 | 120,882 |
| Flammable solid, NOS | 12 | 249 | 2 | 6,002 | 13 | 2,846 | 37 | 2,370 | 6 | 301 |
| Fluoboric acid | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fuel oil (e.g., diesel, 1-6) | 458 | 29,210,972 | 176 | 13,075,374 | 1 | 176 | 0 | 0 | 2 | 14,950 |
| Gasoline | 96 | 4,510,733 | 177 | 11,156,027 | 2 | 6,509 | 0 | 0 | 0 | 0 |

TABLE G.6–2.—*Hazardous Materials Shipments for Proposed Tritium Supply Technologies and Recycling Sites, 1991*[a] [Page 2 of 3]

| Commodity | INEL | | NTS | | ORR | | Pantex | | SRS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) |
| Hazardous waste (non-RAM) | 0 | 0 | 8 | 8,498 | 13 | 67,001 | 0 | 0 | 31 | 84,477 |
| Helium | 16 | 0 | 10 | 196,002 | 26 | 59,123 | 13 | 4,046 | 3 | 455 |
| Hydrocarbon diluent | 0 | 0 | 1 | 5,000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hydrochloric acid | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 8 | 4,115 |
| Hydrofluoric acid, concentrated | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 150 |
| Hydrofluoric acid, solution, spent | 0 | 0 | 0 | 0 | 1 | 100 | 0 | 0 | 0 | 0 |
| Hydrogen gas | 5 | 1,708 | 0 | 0 | 2 | 4,508 | 3 | 696 | 3 | 304 |
| Hydrogen peroxide | 1 | 20 | 0 | 0 | 3 | 3,940 | 0 | 0 | 6 | 1,125 |
| Lithium metal | 0 | 0 | 0 | 0 | 33 | 17,043 | 71 | 12,999 | 1 | 326 |
| Lubricating oil | 3 | 1,131 | 48 | 228,877 | 20 | 20,380 | 21 | 16,225 | 15 | 16,556 |
| Magnesium, powder, metal and strip | 0 | 0 | 1 | 70,000 | 3 | 708 | 0 | 0 | 0 | 0 |
| Methyl isobutyl ketone | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 420 | 0 | 0 |
| Nitric acid, (40 percent or less) | 1 | 438 | 3 | 30 | 1 | 605 | 0 | 0 | 10 | 10,510 |
| Nitric acid, (over 40 percent) | 0 | 0 | 1 | 6 | 2 | 39,500 | 0 | 0 | 5 | 91,816 |
| Nitric acid, fuming | 1 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 2,420 |
| Nitrogen | 73 | 1,868,275 | 6 | 70,330 | 3 | 44 | 2 | 480 | 0 | 0 |
| Nonflammable gas, NOS | 96 | 121,888 | 122 | 317,950 | 114 | 107,183 | 96 | 45,630 | 49 | 202,915 |
| Organic peroxide, NOS | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 529 | 5 | 129 |
| ORM A, NOS | 3 | 702 | 2 | 804 | 0 | 0 | 8 | 322 | 2 | 387 |
| ORM B, NOS | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ORM C, NOS | 1 | 2 | 3 | 270 | 0 | 0 | 0 | 0 | 0 | 0 |
| ORM D, consumer commodity | 7 | 45,813 | 26 | 9,608 | 0 | 0 | 2 | 594 | 14 | 13,658 |
| ORM E, NOS | 1 | 2 | 2 | 4,150 | 0 | 0 | 0 | 0 | 1 | 496 |
| Oxidizer, NOS | 4 | 1,378 | 18 | 4,886 | 0 | 0 | 7 | 3,485 | 28 | 231,114 |
| Oxygen | 137 | 5,741,266 | 7 | 12,833 | 2 | 33 | 0 | 0 | 0 | 0 |
| RAM, empty packages | 37 | 842,604 | 0 | 0 | 110 | 628,991 | 75 | 551,005 | 42 | 1,922,961 |
| RAM, fissile, NOS | 12 | 236,232 | 0 | 0 | 16 | 18,223 | 0 | 0 | 1 | 504 |
| RAM, fissile, <20 percent U-235 | 0 | 0 | 0 | 0 | 7 | 90,970 | 0 | 0 | 0 | 0 |
| RAM, fissile, >20 percent U-235 | 0 | 0 | 0 | 0 | 2 | 13 | 0 | 0 | 0 | 0 |
| RAM, fissile, HRCQ, IR PINS | 6 | 219,900 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 4,214,075 |

**TABLE G.6–2.—*Hazardous Materials Shipments for Proposed Tritium Supply Technologies and Recycling Sites, 1991*[a] [Page 3 of 3]**

| Commodity | INEL | | NTS | | ORR | | Pantex | | SRS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) | Shipments (number) | Weight (pounds) |
| RAM, instr. and articles | 4 | 235 | 5 | 1,480 | 0 | 0 | 0 | 0 | 4 | 773 |
| RAM, LSA, NOS | 177 | 6,277,183 | 2 | 81,420 | 13 | 79,150 | 1 | 6 | 2 | 29 |
| RAM, LSA, waste | 0 | 0 | 204 | 7,293,198 | 1 | 18,750 | 0 | 0 | 0 | 0 |
| RAM, LTD quant, NOS | 85 | 61,506 | 5 | 30,284 | 97 | 315,878 | 3 | 8,468 | 25 | 62,751 |
| RAM, NOS | 69 | 546,097 | 22 | 825 | 426 | 1,062,587 | 198 | 159,731 | 20 | 162,534 |
| RAM, NOS HRCQ | 0 | 0 | 0 | 0 | 1 | 50,300 | 0 | 0 | 2 | 1,040 |
| RAM, NOS, special | 24 | 11,181 | 27 | 2,078 | 21 | 43,924 | 0 | 0 | 2 | 2,185 |
| RAM, NOS, waste | 0 | 0 | 0 | 0 | 1 | 16,436 | 0 | 0 | 0 | 0 |
| RAM, U-metal, PYROP | 0 | 00 | 0 | 0 | 3 | 1,388 | 0 | 0 | 3 | 0 |
| RAM, U-$NO_3$, solid | 0 | 0 | 0 | 0 | 1 | 30 | 0 | 00 | 0 | 0 |
| Small arms ammunition | 2 | 6,498 | 4 | 4,168 | 31 | 45,359 | 40 | 19,581 | 0 | 0 |
| Sodium hydroxide (caustic soda) | 5 | 235,260 | 1 | 160 | 2 | 39400 | 0 | 0 | 17 | 0 |
| Sodium metal (non-RAM) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 815 | 0 | 0 |
| Sodium nitrate | 1 | 11 | 2 | 624 | 2 | 5,384 | 0 | 0 | 3 | 0 |
| Sulfuric acid | 5 | 192,870 | 1 | 15 | 28 | 1,160,833 | 2 | 141 | 11 | 0 |
| 1,1,1-Trichloroethane | 1 | 3,170 | 0 | 0 | 2 | 42,355 | 0 | 0 | 1 | 0 |
| Wet cell batteries | 9 | 738 | 90 | 593,257 | 0 | 0 | 32 | 28,971 | 42 | 51,649 |

[a] Includes both Complex and other DOE commercial hazardous materials shipments to and from these locations. It does not include DOE-controlled classified shipments.
Source: SAIC 1992a:2.

**TABLE G.6–3.—*Air Mileage Between Selected Sites***

| Site | SRS | Pantex | ORR | NTS | INEL |
|---|---|---|---|---|---|
| INEL | 1,550 | 720 | 1,395 | 495 | |
| NTS | 1,705 | 705 | 1,570 | | 495 |
| ORR | 190 | 875 | | 1,570 | 1,395 |
| Pantex | 1,010 | | 875 | 705 | 720 |
| SRS | | 1,010 | 190 | 1,705 | 1,550 |

Source: DOE 1994b:1.

## G.7 Largest Components Requiring Transportation

The reactor vessel and steam generator are unusually large components that require special consideration for transport to the site for installation. Table G.7–1 provides the weight and dimensions for representative reactor vessels and steam generators for each of the reactor technologies.

## G.8 Tritiated Heavy Water

Tritiated heavy water is required only for the Heavy Water Reactor (HWR) and the Accelerator Production of Tritium (APT) technologies.

Locating an HWR at INEL, NTS, ORR, or Pantex would require the one-time shipment of approximately 680 metric tons of tritiated heavy water from SRS to the selected site for the initial filling of the reactor's primary coolant system. Transporting this amount would require an estimated 38 truckloads of 18 tons each, or 80 55-gallon drums per truckload. The level of tritium contamination in the heavy water varies from 3 to 13 curies per liter (Ci/l). At the maximum concentration, a truckload would not exceed $2x10^5$ Ci of tritium. Transporting heavy water for the initial filling would occur within a 1-year period (DOE 1991k:K-12, K-24). DOE evaluated the risk of transporting tritiated heavy water from SRS to INEL (DOE 1991k:K-30, K-32); this also represents a typical route in this PEIS. Based on the assessment, the estimated cancer fatalities resulting from potential traffic accidents associated with the transport of tritiated water would be $3.57x10^{-5}$.

During the reactor's 40-year lifetime, additional heavy water would be needed for makeup from leaks, transport to the Spent Nuclear Fuel Storage Basin, and maintenance activities. The total amount of heavy water required to be transported could be the remainder of the 1,700 metric tons inventory available at SRS. The potential annual cancer fatalities from traffic accidents to transport the entire 1,700 metric tons inventory to meet both the initial filling and replenishment needs is estimated to be $8.94x10^{-5}$.

Locating the APT technology at INEL, NTS, ORR, or Pantex would require the shipment of approximately 86 metric tons of tritiated heavy water from SRS for the initial fill of the helium-3 target and approximately 1 metric ton annually for makeup. The total amount of heavy water to be transported for the life of the APT would be approximately 126 metric tons. The potential annual cancer fatalities from traffic accidents to transport the entire amount of heavy water for the APT is estimated to be $6.63x10^{-6}$.

Because tritium is a beta emitter, the radiological risk from incident-free transportation is extremely small.

**Table G.7–1.—*Representative Vessel and Steam Generator Size***

| | Reactor Vessel | | | Steam Generator | | |
|---|---|---|---|---|---|---|
| **Type of Reactor** | **Weight (tons)** | **Length (ft)** | **Outside Dimensions (ft)** | **Weight (tons)** | **Length (ft)** | **Outside Dimensions (ft)** |
| Heavy Water Reactor | 130 | 32 | 20 | NA | NA | NA |
| Modular High Temperature Gas-Cooled Reactor | 893 | 74 | 25 | 355 | 92 | 17 |
| Advanced Light Water Reactor | 480 | 43 | 20 | 310 | 75 | 16 |
| Boiling Water/ Advanced Light Water Reactor | 350 | 73 | 22 | NA | NA | NA |

Note: NA - not applicable.
Source: DOE 1994c:1.

# APPENDIX H

# Appendix H

# APPENDIX H: ENVIRONMENTAL MANAGEMENT

This appendix provides: an overview of the Department of Energy (DOE) environmental restoration and waste management program including the categories of waste streams managed by the department; the applicable Federal statutes and DOE orders; waste minimization and pollution prevention; waste treatment, storage, and disposal; transportation of wastes; and, finally, facility transition management. Site-specific waste management activities will follow in section H.2. Project-specific waste management activities are addressed in appendix section A.2.

## H.1 OVERVIEW

### H.1.1 Waste Categories

Wastes are generated in gaseous, liquid, and solid form and are categorized by their health hazard and handling requirements. The categories are listed in table H.1.1–1.

### H.1.2 Applicable Federal Statutes and Department of Energy Orders

In order to operate at most of its facilities, DOE has entered into numerous agreements with states and Environmental Protection Agency (EPA) to address compliance issues concerning certain aspects of environmental regulatory requirements that have arisen due either to the age of the DOE facilities or the uniqueness of DOE operations. For the most part, the DOE facilities are in compliance with the major portion of all environmental regulatory requirements and these compliance agreements address only a few specific situations. At the same time, most of these compliance agreements include a commitment from DOE to achieve compliance with the specific requirement by a specified date and a schedule and milestones for achieving that compliance. These agreements guide DOE activities at the sites under applicable environmental laws, regulations, and other standards. Compliance with the terms of these negotiated agreements is one of the highest DOE priorities. Site operations will be conducted consistent with commitments DOE has made and will make in these agreements. DOE will work with the regulators to amend existing agreements and to develop new agreements to ensure continued compliance. Under no circumstances will DOE's performance pursuant to any existing compliance agreement be compromised or diminished as a result of the proposed action.

Most of the regulations that impact the storage, treatment, and disposal of wastes were promulgated since the original Nuclear Weapons Complex (Complex) was established. In many cases, the technology available at the time the Complex was constructed does not meet current requirements for full compliance and, as a result, interim agreements have been made with the regulatory agencies. Through continuous upgrade programs, processes have been improved or added to meet the new regulations. Operations continue on the basis of using "best available technology" for facilities that were in operation before the regulation came into effect. In the siting and construction of new facilities, the intent is to meet current regulations and to reach the goal of maximum recycle, minimal waste generation, no liquid discharges to the surface, and to treat and stabilize unavoidable wastes sufficient for long-term storage or permanent disposal either onsite or offsite.

The following summarizes the applicable Federal statutes and DOE orders:

***Atomic Energy Act.*** The *Atomic Energy Act* gives DOE the authority to manage and regulate nuclear materials handled and generated at its facilities; however, DOE seeks to make its internal guidelines consistent with standards applied to commercial nuclear facilities regulated by the Nuclear Regulatory Commission (NRC). Pursuant to the *Atomic Energy Act*, DOE is committed to the practice of "as low as reasonably achievable" exposure to radiation from its operations whereby exposures and resultant doses are maintained as low as social, economic, technical, and practical considerations permit.

***Resource Conservation and Recovery Act.*** The *Resource Conservation and Recovery Act* (RCRA) was passed in 1976 as an amendment to the *Solid Waste Disposal Act* of 1965. RCRA regulates the "cradle to grave" management (generation, accumu-

**TABLE H.1.1–1.—*Waste Categories***

| Category | Characterization |
|---|---|
| Spent nuclear fuel | Nuclear reactor fuel that has been irradiated to the extent that it has undergone significant isotopic change to the point that fission-product poisons have reached an uneconomic threshold. DOE is no longer reprocessing spent nuclear fuel solely to recover fissile and fertile material. |
| High-level | Highly radioactive waste that results from the reprocessing of spent nuclear fuel used to make nuclear weapons or energy, including liquid waste produced directly in reprocessing, and any solid waste derived from the liquid that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation. |
| Transuranic | Radioactive waste contaminated with alpha-emitting elements with a higher atomic number than uranium, half lives greater than 20 years, and in concentrations greater than 100 nanocuries per gram. Such wastes result primarily from fuel reprocessing and from the fabrication of plutonium weapons components and plutonium-bearing reactor fuel. Generally, little or no shielding is required ("contact-handled" transuranic waste), but energetic gamma and neutron emissions from certain transuranic nuclides and fission-product contaminants may require shielding or remote handling ("remote-handled" transuranic waste). |
| Low-level | Radioactive waste that is not spent nuclear fuel, high-level waste, transuranic waste, or by-product material as defined by DOE Order 5820.2A. Includes research and development fissionable test specimens with transuranic less than 100 nanocuries per gram. The radiation level from this waste may sometimes be high enough to require shielding for handling and transport. In 10 CFR 61, NRC defines four disposal categories of LLW that require differing degrees of confinement and/or monitoring: classes A, B, C, and Greater-Than-Class C. |
| Hazardous | Nonradioactive waste which has characteristics identified by either or both of the following Federal statutes: the RCRA, 40 CFR 261, as amended, or the *Toxic Substances Control Act*. These toxic, corrosive, reactive, or ignitable substances, or RCRA-listed wastes have been identified as posing health or environmental risks. Hazardous waste includes chemicals, such as chlorinated and nonchlorinated hydrocarbons, explosives, leaded oil, paint solvents, sludges, acid, organic solvents, heavy metals, and pesticides. |
| Mixed | Waste containing both hazardous and radioactive constituents. |
| Nonhazardous (sanitary) | Solid sanitary waste includes garbage and is routinely generated by normal housekeeping activities and does not have a defined health risk (neither radioactive nor hazardous). Solid sanitary waste is regulated under RCRA, Subtitle D. Liquid sanitary waste includes sewage and industrial waste, which are treated in a wastewater process before discharge to a publicly owned treatment works or surface waters. The management of liquid sanitary waste is regulated by the *Clean Water Act* and the National Pollutant Discharge Elimination System. |
| Nonhazardous (other) | Other wastes that do not have a defined health risk such as process wastewater. |

lation, storage, treatment, recycle, transport, and disposal) of hazardous waste, nonhazardous waste, underground storage tanks containing petroleum products and hazardous substances, and medical waste. Subtitle C of RCRA mandates that hazardous wastes be treated, stored, and disposed of in a matter that will minimize the threat to human health and the environment. To carry out this mandate, RCRA requires that owners and operators of hazardous waste treatment, storage and disposal facilities obtain operating or post-closure care permits for certain waste management activities. RCRA defines the requirements for treatment, storage, and disposal facilities. Subtitle D of the law addresses the management of nonhazardous solid waste. Title 40 of the *Code of Federal Regulations* implements the statutory provisions of RCRA.

**Land Disposal Restrictions.** The Hazardous and Solid Waste Amendments to RCRA enacted in 1984 required EPA to evaluate all listed and characteristic hazardous wastes according to a strict schedule and to develop requirements by which disposal of these wastes would be protective of human health and the environment. The implementing regulations for accomplishing this statutory requirement are established with the Land Disposal Restrictions program. The Land Disposal Restrictions regulations (40 CFR 268) impose significant requirements on waste management operations and environmental restoration activities. For hazardous wastes restricted by statute from land disposal, EPA is required to set levels or methods of treatment that substantially reduce the waste's toxicity or the likelihood that the waste's hazardous constituents will migrate. After the Land Disposal Restrictions effective date, restricted wastes that do not meet treatment standards are prohibited from land disposal unless they qualify for certain variances or exemptions. EPA has promulgated standards for each of the five statutorily designated categories through the following Land Disposal Restrictions rulemakings:

- **Solvent Dioxin Rule.** Land disposal restrictions and corresponding treatment standards for solvents and dioxins, including mixed wastes containing solvents and dioxins, went into effect on November 8, 1986, and November 8, 1988, as set forth in 40 CFR 268.30 and 40 CFR 268.31, respectively.

- **California List Rule.** Land disposal restrictions and corresponding treatment standards for California list wastes, including mixed wastes containing California list wastes, went into effect on July 8, 1987, as set forth in 40 CFR 268.32.

- For the remaining listed or identified wastes, the Hazardous and Solid Waste Amendments directed EPA to establish a three-phased schedule for the effective date of land disposal restrictions and the promulgation of treatment standards by EPA. Land disposal restrictions and corresponding treatment standards for these scheduled wastes are set forth in 40 CFR 268.33 through 268.35. For the "scheduled wastes" that were the hazardous waste component in mixed waste, EPA deferred issuing treatment standards until the issuance of the last phase (the Third Thirds Rule) on June 1, 1990. This rule established a national capacity variance for mixed wastes identified as hazardous because they contain a component that was a first third, second third, or third third scheduled hazardous waste.

In addition to prohibiting disposal before appropriate treatment, land disposal restrictions prohibit any storage of Land Disposal Restrictions-prohibited hazardous wastes (including mixed waste) except "for the purpose of the accumulation of such quantities of hazardous waste as are necessary to facilitate proper recovery, treatment, or disposal" (40 CFR 268.50). EPA has determined that storage of a hazardous waste pending development of treatment capacity does not constitute storage to accumulate sufficient quantities to facilitate proper recovery, treatment, or disposal.

**Underground Storage Tank Provisions.** The requirements for the facilities that use tank systems for storing or treating hazardous waste are outlined in 40 CFR 264, Subpart J. These requirements include the assessment of the existing tank system's integrity, the design and installation of new tank systems or components, and secondary containment. Hazardous wastes or treatment reagents are not placed in a tank system if they could cause the tank, its ancillary equipment, or the containment system to rupture,

leak, corrode, or otherwise fail. Controls and practices to prevent spills and overflows from tank or containment systems are also required. Inspection requirements, procedures for response to leaks or spills, the disposition of leaking or unfit-for-use tanks, and closure and post-closure care requirements are also outlined in 40 CFR 264, Subpart J. Ignitable or reactive and incompatible hazardous wastes have special requirements.

***Resource Conservation and Recovery Act* Corrective Action Program.** Hazardous waste permits require sites to institute corrective action programs for investigating Solid Waste Management Units. This program applies to all operating, closed, or closing RCRA facilities.

***Federal Facility Compliance Act.*** The *Federal Facility Compliance Act* was passed in 1992 and includes provisions concerning DOE compliance with RCRA land disposal restrictions requirements for mixed waste. The *Federal Facility Compliance Act* requires DOE to have approved site-specific mixed waste treatment plans and related orders in place three years from the date of enactment in order to avoid the imposition of fines and penalties (except for sites already subject to a permit, agreement, or order addressing compliance with the RCRA land disposal restrictions storage prohibition).

In an April 6, 1993, *Federal Register* notice (58 FR 17875), DOE published its schedule for submitting plans for treating mixed wastes for each facility at which DOE generates or stores mixed waste. DOE has published two interim versions of the plans required by the *Federal Facility Compliance Act* for each of its sites to facilitate discussions among states and other interested parties. DOE is working on the plans with the regulatory agencies and will continue to do so throughout the process. For mixed waste for which identified treatment technologies exist, the plans must provide a schedule for submitting permit applications, entering into contracts, initiating construction, conducting systems testing, starting operations, and processing mixed wastes. For mixed waste without an identified treatment technology, the plans must include a schedule for identifying and developing technologies, identifying the funding requirements for research and development, submitting treatability study exemptions, and submitting research and development permit applications. In cases where DOE proposes radionuclide separation, the plan must also provide an estimate of the volume of waste that would exist without such separation, and cost estimates and underlying assumptions. DOE sites will provide treatment plans in three phases during the development process: Conceptual plans were completed in October 1993 and draft plans in August 1994. Final proposed plans are due to be completed no later than February 1995. DOE will also prepare summary documents of the conceptual, draft, and final plans to provide a national picture of DOE's technology needs and possible options for treatment of its mixed waste. The summaries will be provided to all states and made available to other interested parties.

***Comprehensive Environmental Response, Compensation, and Liability Act.*** The *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act* (SARA) of 1986, provides liability, compensation, cleanup, and emergency response for hazardous substances (including radionuclides) released to the environment. The cleanup of inactive waste disposal sites is one of the major requirements of CERCLA. It provides for prioritization of cleanup actions (National Priorities List (NPL) or Superfund List), and directs that a Federal Facility Agreement be negotiated with EPA and the state to coordinate CERCLA and RCRA compliance activities in one comprehensive strategy for each Federal facility. CERCLA also requires public participation in the selection of remediation alternatives, and this involvement or participation usually addresses the requirements of CERCLA, RCRA and the *National Environmental Policy Act* (NEPA). Title III of CERCLA further requires that the National Response Center (operated by the U.S. Coast Guard) be notified in the event that a non-permitted release of a reportable quantity of hazardous substance or radionuclide occurs. In the case of such a release, the National Response Center alerts the appropriate Federal emergency personnel who assess the event, formulate response, and notify cognizant local emergency agencies. SARA requires industries to report the hazardous substances used at their facilities to include reporting inventories of these substances.

**National Contingency Plan.** The National Contingency Plan is an implementation regulation that sets forth requirements necessary to comply with CERCLA and SARA. For every site that is targeted for remedial response action under Section 104 of CERCLA, the National Contingency Plan requires that a detailed remedial investigation/feasibility study be conducted. The remedial investigation emphasizes data collection and site characterization. Its purpose is to define the nature, extent, and significance of contamination at a site in order to evaluate, select, and design a cost-effective remedial action. The feasibility study emphasizes analysis of data and decision making; it uses results from the remedial investigation to develop response objectives and alternative remedial responses. These alternatives are then evaluated in terms of their engineering feasibility, public health protection, environmental impacts, and costs. The remedial investigation/feasibility study leads to a decision which sets forth the method selected for remedial action to clean up the National Priorities List site. Under the provisions of CERCLA, Federal facilities have the lead for CERCLA actions.

***Toxic Substances Control Act.*** TSCA was enacted in 1976 to ensure that the manufacture, sale, storage, and disposal of toxic chemical substances do not present an unreasonable risk of injury to health or the environment. Its applicability to DOE sites deals principally with the management and disposal of polychlorinated biphenyls (PCBs), asbestos, and dioxin. The problem created by radioactively-contaminated PCBs, asbestos, and dioxin is that currently there is a limited capability to treat these materials. Although the concentrations of radionuclides are relatively low, approximately 2 million pounds of radioactively-contaminated PCBs and PCB-contaminated material are destroyed annually by the K-1435 TSCA Incinerator at K-25 at Oak Ridge Reservation (ORR).

***Clean Air Act.*** The original *Clean Air Act* (CAA) was passed in 1955 and was wholly replaced by the *Air Quality Act* of 1967, although the name *Clean Air Act* is still used. It has been recently reauthorized. The CAA establishes air quality requirements and pollutant emission limits. The National Emissions Standards of Hazardous Air Pollutants (NESHAP) is a section of the CAA that sets air quality standards for air emissions such as radionuclides, benzene, beryllium, and asbestos. NESHAP regulations require the use of EPA-approved monitoring instrumentation, sampling methodology, calculations, and modeling for each Federal facility.

***Clean Water Act.*** The *Federal Water Pollution Control Act* (CWA), as amended by the *Clean Water Act* of 1977 (commonly referred to as *Clean Water Act*), establishes a Federal/state scheme for controlling the introduction of pollutants into the nation's water. The CWA created the National Pollutant Discharge Elimination System (NPDES) program. This program regulates nonradiological effluent discharges to ensure that surface water bodies meet applicable water quality standards. Each discharge point (outfall) is permitted through the NPDES program. New NPDES permit regulations for stormwater discharges will require DOE to characterize surface runoff during rain events.

***Safe Drinking Water Act.*** The *Safe Drinking Water Act* (SDWA) was enacted in 1975 and is designed to protect drinking water resources. Primary drinking water standards set by the SDWA apply to drinking water "at the tap" as delivered by public water systems. Of equal significance is that drinking water standards are used to determine groundwater protection regulations under a number of other statutes. The SDWA requires DOE to obtain permits and complete sample analyses and site inspections of public/industrial water supplies and sources of drinking water. It also imposes requirements on installation and maintenance of drinking water wells.

**Department of Energy Orders.** The primary DOE orders governing waste management are as follows:

- DOE Order 5400.1, *General Environmental Protection Program.* Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations for assuring compliance with applicable Federal, state, and local environmental protection laws and regulations, Executive orders, and internal department policies. Requires the preparation of waste minimization plans that describe how waste minimization activities will be promoted and implemented.

- DOE Order 5400.4, *Comprehensive Environmental Response, Compensation and Liability Act Requirements*. Establishes DOE's instructions for implementing CERCLA program and defines actions to identify and evaluate inactive waste sites at DOE installations. Directs the custodian to take action to improve control of substance migration from such sites.

- DOE Order 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*. Establishes the requirements for the packaging and transportation of hazardous materials, hazardous substances, and hazardous wastes.

- DOE Order 5820.2A, *Radioactive Waste Management*. Establishes policies and guidelines by which DOE manages its radioactive waste, waste by-products, and radioactively-contaminated surplus facilities.

### H.1.3 Waste Minimization and Pollution Prevention

Waste minimization is the reduction, to the extent feasible, of radioactive and hazardous waste that is generated *before* treatment, storage, or disposal of the waste. Pollution prevention fully utilizes source reduction techniques in order to reduce risk to public health, safety, welfare, and the environment, and environmentally sound recycling to achieve these same goals. When planning for facilities to be constructed by 2010, it will be necessary to consider currently available technology while providing modular, flexible designs that can incorporate process improvements as they become available. In accordance with Executive Orders 12856, 12873, and DOE policy, the tritium supply and recycling facilities would be designed for waste minimization with an overall operating philosophy of pollution prevention. This waste minimization program will contribute to decreases in waste treatment, storage, and disposal costs and lower health risks to workers and the public. Technical approaches are being sought to optimize the number of production operations required, increase the use of nonhazardous chemicals and environmentally benign waste-producing chemicals, increase the use of recyclable chemicals and materials, and implement the new design or redesign of existing processes and products. Some criteria useful in determining successful technology include improved processing yield, reduced quantities of scrap, reduced waste and processing of by-products, reduced use of hazardous chemicals, positive return on investment, and continued product quality.

### H.1.4 Waste Treatment, Storage, and Disposal

Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, which may be performed on a waste prior to either storage or disposal or both. Stored waste is a waste that, following generation (and usually some treatment), is being (temporarily) retained in a retrievable manner and monitored pending disposal. Disposed waste is a waste that has been put in final emplacement to ensure its isolation from the environment, with no intention of retrieval. Deliberate action is required to regain access to the waste. Disposed wastes include materials placed in a geologic repository and buried in landfills.

Waste that is staged for processing will be stored according to its characterization and form. The disposal of waste from the Complex will be managed by the DOE Office of the Assistant Secretary for Environmental Management (EM). A facility for disposal of retrievable and newly generated transuranic (TRU) waste near Carlsbad, NM is planned. All surface facilities at the Waste Isolation Pilot Plant (WIPP) have been completed. To date, only underground excavations for the test phase have been done and the remaining excavation will be completed once the facility is operational. The orginal planned test phase has been abandoned and in its place an experimental program at INEL will be conducted to develop the technical data to support the permit application under 40 CFR 191 and 40 CFR 268. Once operational, WIPP would become a permanent disposal site. The total projected capacity of WIPP is 229,600 $yd^3$, of which 9,260 $yd^3$ can be remote-handled. Options for the interim storage of TRU waste will be evaluated in the EM PEIS. Yucca

Mountain is a site being studied to determine its suitability for the disposal of commercial spent nuclear fuel and defense high-level waste (HLW). Since the availability of offsite disposal sites for HLW, TRU waste, mixed waste, and spent nuclear fuel is uncertain at this time, this PEIS has evaluated the storage of mixed waste and spent fuel within the Complex for the life of the facilities that generate the waste. No HLW or TRU waste will be generated as part of tritium supply and recycling. The remainder of this section discusses some of the treatment, storage, and disposal options that may be utilized with the various waste streams from Complex facilities.

**Gaseous Waste.** Gaseous wastes can be nonhazardous (e.g., inert gases and air), hazardous (chlorinated hydrocarbon vapor, polyaromatic hydrocarbon vapor), or radioactive (e.g., tritium and xenon). Most hazardous gaseous wastes are combustible, and may be incinerated to destroy the hazardous constituents, converting the combustibles into carbon dioxide and water vapor, while capturing any particulates that may result. When a particulate (ash) is contaminated with heavy metals, the end product must be stabilized into an approved solid form suitable for disposal.

Gaseous radioactive wastes are held for interim storage in tanks; adsorbed on surfaces in filters, molecular sieves, or active beds; refrigerated and liquefied or solidified; or reacted to an aqueous solution. A minimal quantity of radioactive gas below the permitted limits will escape to the atmosphere because it is not possible to retain every atom of gas within the process with today's technology. The expected release of radioactive gases is listed in the project descriptions in section A.2. Gaseous waste may be oxidized, mixed with other liquid wastes, or solidified in a stable form for long-term disposal. Reactive gases such as tritium are captured on reactive beds, in molecular sieves, or in cryogenic traps for recycling back to the process. Inert radioactive gases such as xenon and argon can be separated by cryogenic capture and held in storage tanks until they decay sufficiently to permit release. Gases that decay to metals can be captured on activated charcoal beds and held until they can be stabilized, packaged, and disposed of as solid waste. When sufficiently decayed, gases may be released to the atmosphere.

**Liquid Waste.** Liquid radioactive wastes are processed according to their chemical nature and radiological sources and activities. Liquid wastes that meet release criteria in applicable regulations can be released at permitted discharge points. Where conditions permit, liquids can be processed and recycled to replace virgin feedstocks. Waste processing removes the hazardous or radioactive contaminants from the releasable or recyclable liquids. The largest volume of liquid radioactive waste is LLW, typically in aqueous solution from process operations. Some of this waste is contaminated with hazardous compounds such as solvents or resins and the result is a liquid mixed waste. Liquid HLW or TRU waste will not be generated in tritium supply and recycling facilities, but will be part of the reference conditions at candidate sites where spent fuel or target processing was conducted. This includes wastes containing TRU, as from the extraction of plutonium. The desired final waste form for liquid wastes is a stable solid that is resistant to stresses from heat generation and from internal and external physical loads. The form must remain stable while stored and not allow the radioactive constituents to migrate to the surroundings.

Mixed waste will often have combustible constituents. These are most readily decomposed in thermal treatment (incineration) or chemical reaction resulting in the creation of an ash. The resulting material will be granular and suitable for stabilization in a cemented form in which the hazardous constituents (radionuclides and heavy metal compounds) are bound in compounds which have an affinity for heavy metals and radionuclides. These processes have been utilized in various forms, and their retention properties have been credibly demonstrated.

Liquid LLW is normally processed to reclaim or remove the excess water, leaving a saturated salt solution. This can be accomplished by clarification processes normal to water treatment, or by evaporation. This usually results in the greatest volume reduction for liquid waste. The subsequent stabilization and solidification of the concentrated solution results in a waste form that will not leach its active constituents for a time sufficient to allow the radioactive constituents to decay.

A method for stabilizing HLW for disposal is to process it into borosilicate glass cast within stainless steel cylinders. These are shock-resistant, elastic forms suitable for permanent disposal in an engineered repository. They also provide excellent retention during long-term interim storage. In the preferred practice, the liquid waste stored in large tanks is pumped directly into the vitrification process where the liquid is evaporated and the remaining salt is fused with borosilicate into the glass waste form. In some processes (i.e., at INEL's Idaho Chemical Processing Plant), the waste is evaporated to calcine which is stored in a granular form for later processing. The disadvantage of this process is that airborne particulate matter is generated when the product is handled. The advantage is that the calcine can be stored safely in a stable form until it can be vitrified.

Liquid radioactive and hazardous wastes are usually stored in tanks where they are staged for further processing. Processes are employed to concentrate the hazardous constituents. These processes result in very significant volume reductions, with the reclaimed water processed to a purity sufficient for permitted discharge or recycle.

Liquid hazardous waste concentrates may contain combustive hydrocarbons and/or heavy metal contaminants. These can be treated by incineration to produce a dry waste. If this waste is still hazardous after treatment, it can then be processed into a stabilized solid that will not leach its hazardous constituents while in storage or in a repository. Liquid low-level and noncombustible hazardous waste can also be processed into a stabilized solid form for storage and disposal.

**Solid Waste.** Solid radioactive wastes typically consist of contaminated materials (e.g., filters, clothing, storage vessels, cleaning materials, and tools) that have been used in or contaminated by nuclear materials processing. The term is also applied to those stabilized forms resulting from gaseous or liquid waste processing. In solid waste handling, forms and materials are segregated, combustibles are incinerated, and the resultant materials are reduced in volume, stabilized if necessary, and packaged in specified containers for storage or disposal.

HLW is stored at two of the sites considered for tritium supply and recycling. It is stored as calcine granules at Idaho National Engineering Laboratory (INEL) in underground vaults and in tanks as liquids at Savannah River Site (SRS). It will be processed to a glass/ceramic (INEL) and borosilicate glass (SRS), stored in an engineered facility onsite, and eventually shipped to a Federal repository.

Dry LLW that consists of protective clothing, containers, process materials, and equipment is stored in specified containers designed to retain the waste constituents for a time sufficient to permit decay of the radioactive constituents.

Solid hazardous wastes may contain combustible hydrocarbon compounds or mixtures with heavy metal contamination. These wastes are often treated by incineration and disposed of in a landfill if the ash is nonhazardous. If the ash contains heavy metals it can be stabilized with cement and binders and disposed of in a RCRA-permitted facility. Wastes that retain their hazardous constituents after processing must be packaged into forms that will retain the hazardous constituents safely within the waste form. For LLW or hazardous waste that results from liquid waste processing or incineration, the accepted form is a cemented solid.

Some mixed waste can be processed to remove its hazardous constituents and be disposed of as LLW. Otherwise, it can be processed into stabilized forms and packaged for retrievable storage in an engineered facility until a licensed facility is available for permanent disposal. Solid nonhazardous wastes from process wastewater evaporation ponds or from sanitary waste treatment plants are usually deposited as sludge in a landfill.

**Spent Nuclear Fuel.** As described in each of the technology descriptions in appendix section A.2, spent nuclear fuel from the reactor-based tritium supply alternatives will be stored within the tritium supply facility. The fuel will be kept in water-cooled storage until its decay heat has decreased sufficiently to permit dry storage. Several commercially-available options for dry storage have been licensed by the NRC, and the facilities required will be relatively small, utilizing a small percentage of the land area required for the tritium supply plant. Spent nuclear fuel will not be reprocessed but will eventu-

ally be placed in a Federal repository. Spent nuclear fuel is considered a resource, not categorized with nuclear waste, and thus is not included in waste inventories. Since it is radioactive material that must be stored, managed and handled, it is included here for each site to provide baseline information on its impact on land and facility use.

### H.1.5 Transportation

DOE complies with applicable Department of Transportation (DOT) regulations (10 CFR 71 and 49 CFR) when shipping hazardous materials over public roads. Transportation, especially for radioactive material, is highly regulated by Federal, state, and local laws. The stringent packaging requirements, combined with strict regulations and procedures governing the shipment of hazardous and radioactive material, ensure that transport is a safe activity. Federal DOT regulations require the use of appropriate warning placards on vehicles and labels on packages to alert workers, officials, and the public to the hazardous nature of the shipped material. The use of placards on vehicles and warning labels on packages is a joint responsibility of the carrier and the shipper. The labels and placards are familiar to emergency response personnel and are valuable in determining content and hazard information.

Shipments of hazardous materials, including radioactive materials, must be accompanied by properly completed shipping papers such as bills of lading and cargo manifests, which contain detailed information on the material being transported. These papers must be kept in the vehicle transporting the material and must be available for inspection by responsible officials at any time. The shipper must certify on the shipping papers that the hazardous material offered for transportation is properly classified, packaged, marked, labeled, and made ready for transportation according to all DOT regulations.

Radioactive material is shipped in secure packages. Type A packages contain small amounts of radioactive material and are designed to withstand normal conditions of transport. Type A packages are subjected to rigorous water spray, free-fall compression, and penetration tests carried out in sequence to ensure that radioactive materials are contained. Type B packaging is designed to contain more hazardous, and larger amounts of, radioactive waste. It can withstand severe accident conditions and contain radioactive materials under any credible circumstance.

With the exception of Pantex, all sites being considered for the tritium supply and recycling facilities either have or have planned an onsite LLW disposal facility. For the purposes of this PEIS, it was assumed that all LLW generated at Pantex would be shipped to NTS per current practice. The additional shipments of LLW from Pantex as a result of locating tritium supply and recycling functions at Pantex were estimated. All LLW would be transported in a solid form. A typical shipment consists of eighty 55-gallon (208-liter) drums loaded into an enclosed semi-trailer type truck. Each drum is assumed to be fully loaded, resulting in a total shipment volume of 21.7 $yd^3$. The truck is assumed to operate as an "exclusive-use" vehicle. The risks associated with these additional shipments are discussed in section 4.7 and appendix G.

### H.1.6 Facility Transition Management

Any transition activities of facilities from a production mode to a cleanup mode that are part of the baseline for this PEIS are discussed in the facility impacts section of chapter 4 and in section H.2 of this appendix. Decontamination and decommissioning (D&D) considerations of Complex facilities will be planned for in the design.

**Existing Facilities.** The DOE Office of the Assistant Secretary for Defense Programs (DP) is responsible for the safe operation, shutdown, and ultimate disposition of facilities used to support the nuclear weapons program. EM is responsible for final facility disposition, which may include decontamination and decommissioning of inactive facilities or refurbishing them for further economic development. Transition activities will require appropriate NEPA evaluation and will proceed consistent with the PEISs within EM and DP. Depending on the site, facility transition activities are in different stages of planning. The dominant time-intensive activities are building characterizations of the environmental hazards related to the building and the deactivation of the facility.

**Complex Facilities.** At the end of their useful life, all potential facilities would require decommission-

ing. The transition process begins when DOE management decides to no longer operate the production facility and ends when responsibility for the facility is formally turned over to EM. Transition plans will be required for all facility transfers to EM. These plans define the actions necessary to bring the identified facilities into a condition acceptable for transfer to EM. Some facility transition issues raised in EM's scoping process for its PEIS which would be considered in the facilities design process are:

- Land use criteria defined for the period after cleanup.
- Interim storage of mixed waste and spent nuclear fuel.
- Disposal facilities for hazardous waste and LLW.

The cleanup of Complex facilities will be significantly less difficult because consideration for waste minimization and ease of decontamination will be included in the facility design. The Complex will be significantly smaller, consume less material, and generate far less contamination during process operations. The elimination of spent fuel processing and plutonium production would greatly reduce waste and contamination volumes. Large storage facilities will not be necessary for liquid radioactive wastes. The surfaces that come in contact with potential contaminants will be easier to decontaminate. In-process decontamination (to reduce operational exposures) will significantly reduce the cleanup required at the end of life.

In spite of the best design and process practices, many of the Complex facilities will require decontamination efforts at the end of life. Because of the necessity of working inside contaminated areas during the cleanup phase, the potential for exposure to cleanup workers is higher than during the operations phase. Workers would wear protective clothing and would be supplied breathing air to minimize their exposure.

Technologies for cleanup are established and are improving as the experience in working with nuclear facilities increases. The use of robotics, improved task planning, and new materials to prevent the spread of contamination has already improved current cleanup activities. By the time the Complex facilities are decommissioned, DOE will have gained 40 more years of cleanup experience; thus, further improvements should be expected.

## H.2 Waste Management Activities

### H.2.1 Idaho National Engineering Laboratory

The activities associated with the development of reactor technology and the extraction of useful nuclear materials at the INEL have produced radioactive, mixed, and hazardous wastes that are treated, stored, or disposed of on the site. The *Environmental Restoration and Waste Management Site-Specific Plan for Fiscal Year 1993* (DOE-ID 10253 (FY 1993)) addresses the tasks of cleaning up existing waste units and bringing operations into compliance with current applicable regulations. It deals in detail with the current conditions, plans for remediation, and development and funding of processes to minimize waste generation and to safely process and dispose of future waste generation.

**Pollution Prevention.** The Idaho Operations Office has an active Waste Minimization and Pollution Prevention program to reduce the total amount of waste generated and disposed of at INEL. This is accomplished by eliminating waste through source reduction or material substitution, by recycling potential waste materials that cannot be minimized or eliminated, and by treating all waste that is generated to reduce its volume, toxicity, or mobility prior to storage or disposal. The Idaho Operations Office published its first waste minimization plan in 1990 which defined specific goals, methodology, responsibility, and achievements of programs and organizations. The achievements and progress have since been updated at least annually.

**Spent Nuclear Fuel.** The inventory of spent nuclear fuel at INEL is cited here in metric tons of heavy metal based on currently available references. One hundred and seventy-seven metric tons of spent nuclear fuel are in storage at the Idaho Chemical Processing Plant and 124 metric tons at the Test Area North. Spent nuclear fuel is stored in facilities designed for a specific fuel type; therefore, storage capacities are not additive for the site. There are 11.6 metric tons of graphite reactor fuel, 10 metric tons of naval reactor fuel, and 279 metric tons of commercial

and research reactor fuels in the inventory (DOE 1993r:b-2). Continued receipt of naval reactor and Ft. St. Vrain gas-cooled reactor fuel would add to this inventory. Spent nuclear fuel is stored at the Power Burst Facility, Test Reactor Area, Test Area North, Idaho Chemical Processing Plant, Argonne National Laboratory-West, and the Naval Reactor Facility. Naval Reactor Facility and Test Reactor Area fuel will be sent to the Idaho Chemical Processing Plant for storage. The Test Area North fuel pool is nearing its design life expectancy. The Three Mile Island core debris stored there will be repackaged and placed in dry storage. One alternative under study is to repackage fuel elements and provide long-term storage at INEL until a Federal repository (Yucca Mountain, NV) is ready to receive them. Gas-cooled reactor and naval fuels are extremely stable and long-term storage in their current configuration does not present significant problems. Experimental Breeder Reactor-II at Argonne National Laboratory-West has its own fuel reconstitution facility and processes the resulting waste in the Argonne National Laboratory-West area.

The treatment of spent nuclear fuel for long-term storage and disposal is expected to continue at INEL for the next 40 years. Existing rulings designate spent nuclear fuel as a recoverable resource, and as such, waste regulations for treatment, storage, and disposal do not apply. There are no plans to dispose of spent nuclear fuel at INEL (DOE 1994e:2-8). Figure H.2.1–1 illustrates spent nuclear fuel management at INEL. The inventories and current plans for the treatment and storage of spent nuclear fuel are being reevaluated as part of the *Department of Energy Programmatic Spent Nuclear Fuel Management Program and Idaho National Engineering Laboratory Environmental Restoration Waste Management Programs EIS*. Shipments of spent nuclear fuel to INEL will be limited to specific quantities of naval spent fuel until the EIS is completed.

**High-Level Waste**. HLW has been generated in the reprocessing of spent nuclear fuel at the Idaho Chemical Processing Plant. Most of this fuel was from the naval reactors program. The liquid HLW is concentrated by evaporation and converted by calcination in a fluidized bed to metallic oxides which are stored in a stable granular solid form. This waste form is stored in stainless steel bins in concrete vaults, where it can be held long enough that the short half-life isotopes have decayed and its activity reduced. This waste form is a mixed HLW because of the toxic metals it contains.

Liquid HLW in acidic solution is stored in stainless steel tanks that may not meet all seismic regulations and do not have a secondary containment system that is acid resistant. The Idaho Operations Office entered into a consent order in April 1992 to resolve secondary containment issues. This consent order requires continued calcination, thus reducing waste volume and resulting in a material that is much easier to handle and store. The calcine, however, does not meet RCRA treatment standards for land disposal. Options for treatment of this waste are under study, and a facility is proposed where this waste will be prepared for disposal (IN DOE 1994a:5-6). The HLW inventory and treatment and storage facilities at INEL are listed in tables H.2.1–1, H.2.1–2, and H.2.1–3. Figure H.2.1–2 illustrates HLW management at INEL.

**Transuranic Waste**. TRU and mixed TRU wastes are stored at the Radioactive Waste Management Complex. Prior to 1970, when the AEC determined that TRU wastes required segregation from other wastes, TRU wastes were buried in earthen trenches. Since that time, TRU wastes have been segregated into contact-handled and remote-handled categories, and packaged and stored for ultimate retrieval and transport to an offsite repository at WIPP. INEL contains 30 percent of DOE's TRU wastes. The majority of TRU wastes at INEL were shipped from other sites, particularly Rocky Flats Plant (now known as the Rocky Flats Environmental Technology Site), but this practice was stopped in 1989.

The existing treatment facilities for TRU wastes at INEL are limited to testing, characterization, and repackaging. The Idaho Waste Processing Facility, now in the planning phase, will process TRU wastes and either reclassify it (if it is found to be LLW) for disposal onsite, or prepare it so that it meets the WIPP Waste Acceptance Criteria. The use of commercial treatment facilities is also being considered. Approximately 60 percent of the TRU waste at INEL will require reprocessing. Volume reduction and the destruction of hazardous constituents in the mixed TRU wastes is being studied. Some of the TRU wastes have radioactivity levels high enough to require remote handling. No certified or licensed

transportation capabilities exist for this waste, so this is another matter under study.

TRU wastes at INEL are being stored pending the outcome of the WIPP program. Assuming WIPP is determined to be a suitable repository for these wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, these wastes will be transported there for disposal. If WIPP proves not suitable for a repository, then INEL would develop the treatment processes necessary to meet the criteria of the selected repository. Tables H.2.1–4, H.2.1–5, and H.2.1–6 list the TRU and mixed TRU waste inventory, and treatment and storage facilities at INEL. Figure H.2.1–3 illustrates TRU waste management at INEL. INEL is not expecting to generate or receive mixed TRU in the next 5 years. Some TRU wastes at INEL will never meet WIPP waste acceptance criteria, and therefore cannot be sent to WIPP. Other options will have to be developed for these wastes. Approximately half of the TRU wastes are expected to be reclassified as alpha-contaminated LLW in the future. These wastes do not meet INEL waste acceptance criteria for LLW, and therefore will be managed as TRU waste.

**Low-Level Waste.** LLW is generated in various forms at INEL facilities. This waste is disposed of at the Radioactive Waste Management Complex. Most of this waste is processed before disposal by incineration, compaction, or sizing to reduce volume and to stabilize the waste to the extent possible (incinerator, which was shut down for modifications, completed startup and resumed limited operations in 1994). Some LLW does not meet criteria for onsite disposal. This waste is stored temporarily until treatment and disposal options are developed. Liquid LLW is either evaporated and processed to calcine, or solidified and disposed of. The volume of LLW disposed of at INEL's Radioactive Waste Management Complex is 189,660 $yd^3$. As of 1991, the facility had a capacity for 235,345 $yd^3$, with an additional 88,000 $yd^3$ of expansion capacity available. Figure H.2.1–5 illustrates LLW management at INEL.

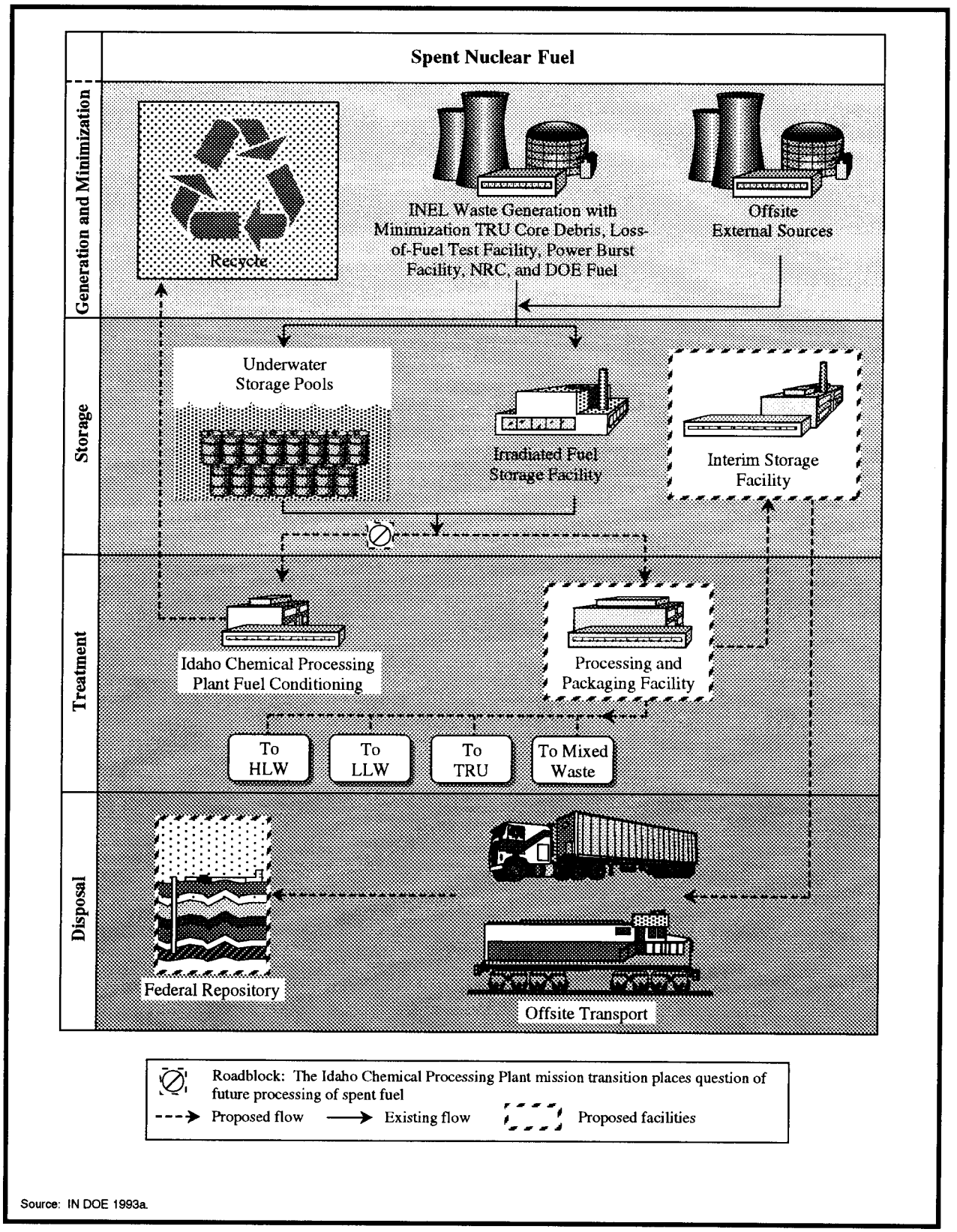
**Mixed Low-Level Waste.** Mixed LLW is generated in small quantities at INEL and is stored in several areas onsite (Argonne National Laboratory-West, Idaho Chemical Processing Plant, Special Power Excursion Reactors Test). Although its volume is small, it poses significant disposal problems because it is difficult to treat and cannot be disposed of until adequate treatment is developed. In the future, the Waste Experimental Reduction Facility incinerator at the Power Burst Facility will process mixed low-level (organic) wastes. Argonne National Laboratory-West plans to complete a multipurpose waste management facility by 1996 which will include provisions for mixed waste. Additional facilities planned for operation by the year 2000 at other INEL locations will be able to treat mixed waste and render it acceptable for disposal. Figure H.2.1–4 illustrates mixed waste management at INEL.

Although mixed wastes generated from past operations in liquid and solid form are stored in many locations at INEL, the bulk of that volume is solid waste stored at the Radioactive Waste Management Complex. Its volume is approximately 60 percent of the TRU waste volume also stored there and is 11 percent of the total volume of waste stored or disposed of at that facility. INEL has listed 34 facilities where mixed wastes are or will be treated to remove, destroy, or stabilize their hazardous constituents in the future, and prepare them for permitted disposal (INEL 1993a:5). The inventory of mixed LLW and its treatment and storage facilities at INEL are listed in tables H.2.1–7, H.2.1–8, and H.2.1–9.

**Hazardous Waste.** Hazardous waste is staged in a RCRA-permitted building at the Central Facilities Area prior to shipment to an offsite commercial RCRA-permitted facility. The Hazardous Waste Storage Facility is nearing capacity since hazardous waste shipments to offsite permitted facilities have been temporarily suspended pending completion of a review by DOE. However, shipments are expected to be resumed in the near future. The INEL waste minimization program is expected to significantly reduce the quantities of hazardous wastes generated at INEL over the next 5 years. By that time, the use of nonhazardous chemicals and the recycle of those that cannot be substituted for, should nearly eliminate the generation of hazardous waste.

**Nonhazardous Waste.** Nonhazardous wastes are processed at each facility on the INEL site. A nonhazardous industrial commercial waste landfill is located at the Central Facilities Area. Wastes are segregated into sanitary, industrial, and asbestos wastes before being placed in the landfill. Increased recycling is expected to reduce nonhazardous waste

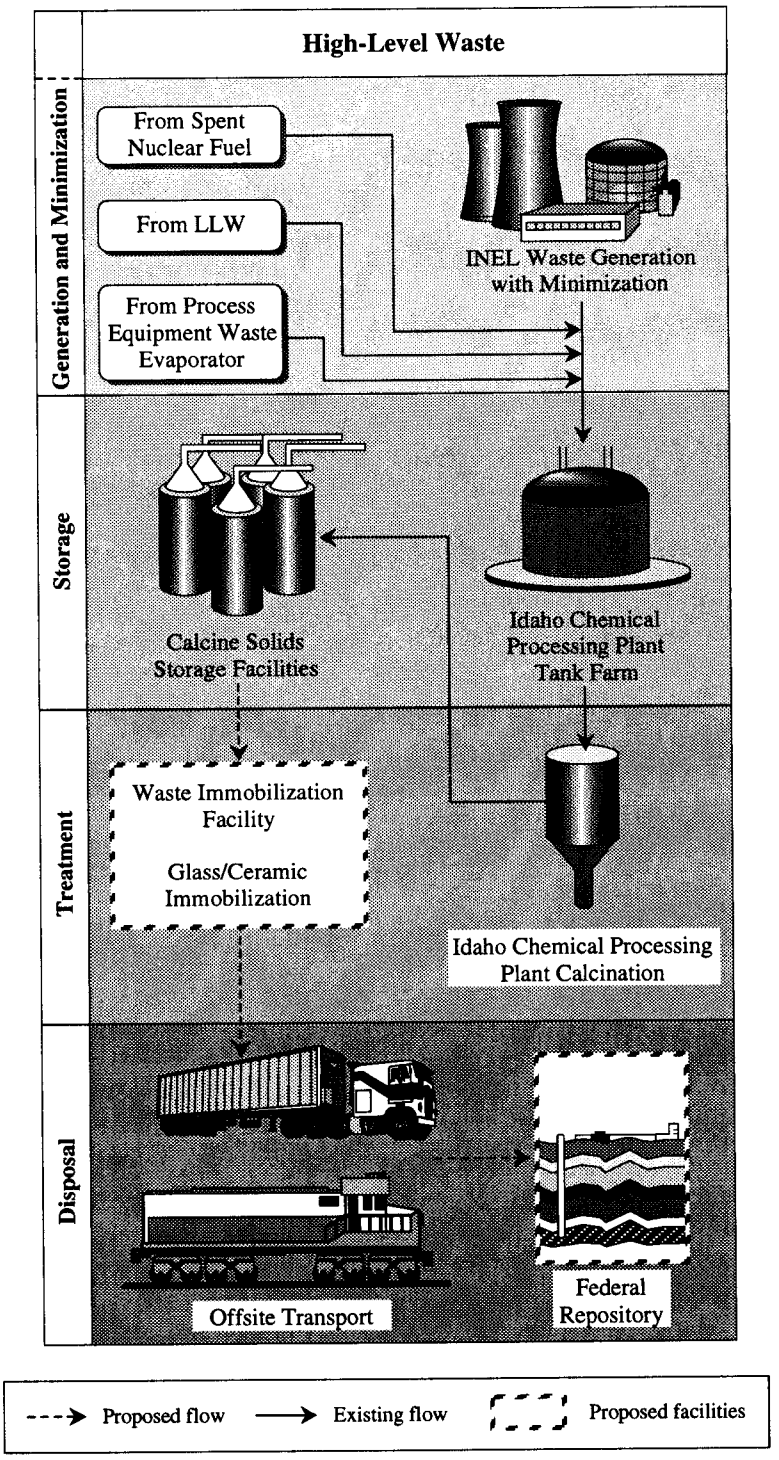
generation by 50 percent by 1997. In the future, sanitary wastes may be sent offsite for disposal in a permitted facility, while industrial and asbestos wastes will continue to be disposed of at INEL. A new multipurpose facility is planned to be in operation at Argonne National Laboratory-West by 1996 to collect, monitor, and consolidate Argonne National Laboratory-West nonhazardous wastes before shipment to the Central Facilities Area.




Source: IN DOE 1993a.

2201

**FIGURE H.2.1–1.—*Spent Nuclear Fuel Management at Idaho National Engineering Laboratory.***




Source: IN DOE 1993a.

2203

**FIGURE H.2.1–2.—*High-Level Waste Management at Idaho National Engineering Laboratory.***

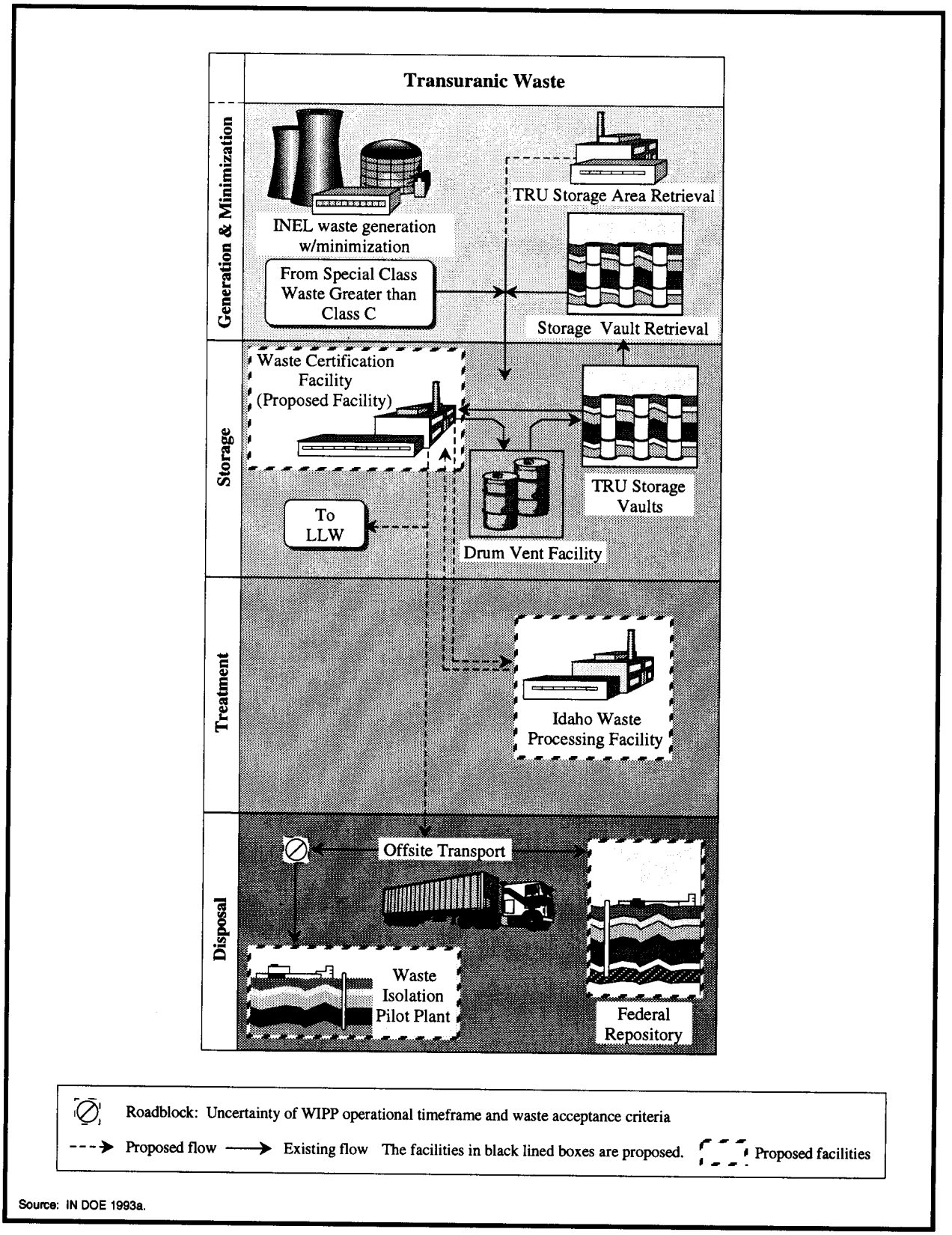



**FIGURE H.2.1–3.**—***Transuranic Waste Management at the Idaho National Engineering Laboratory.***

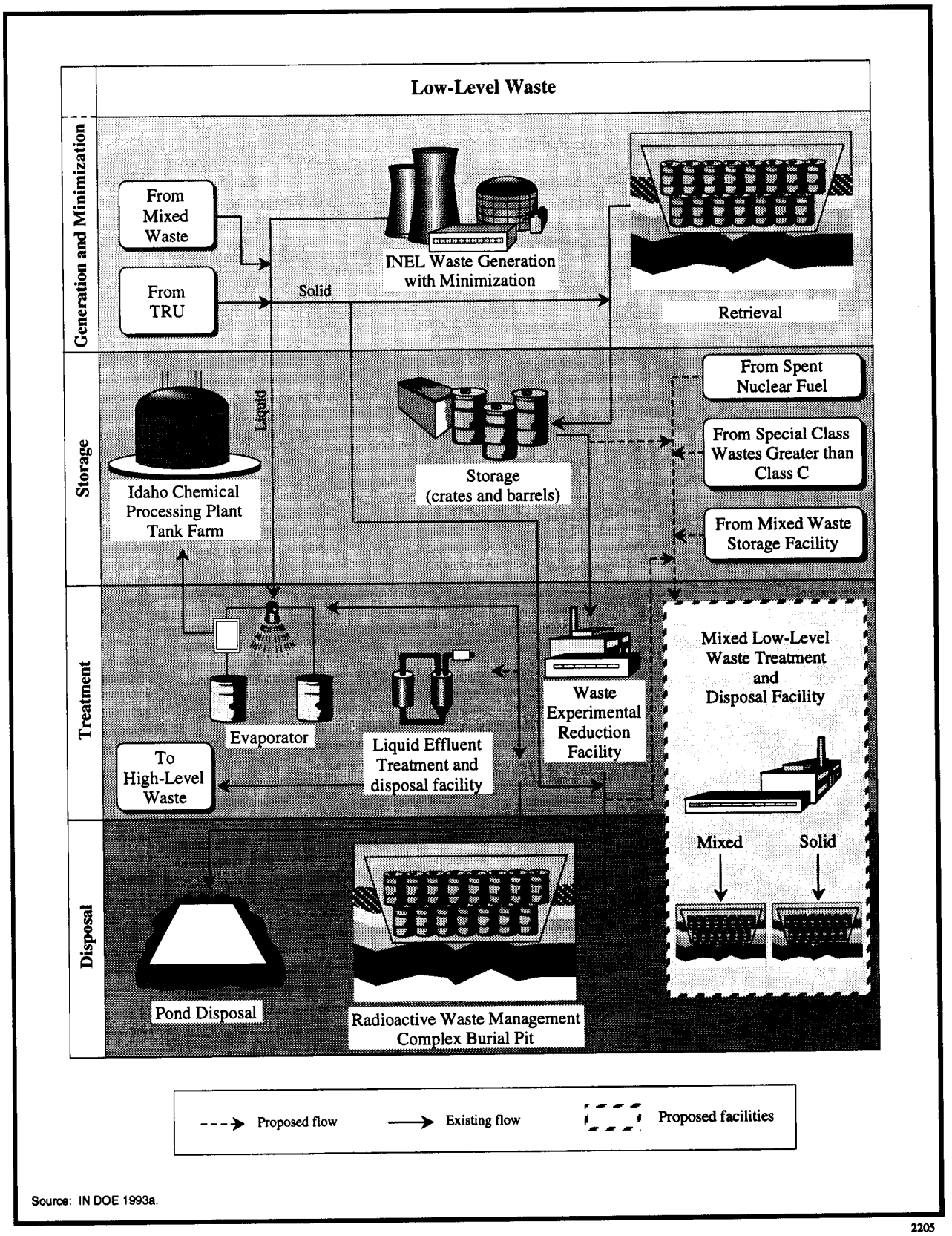
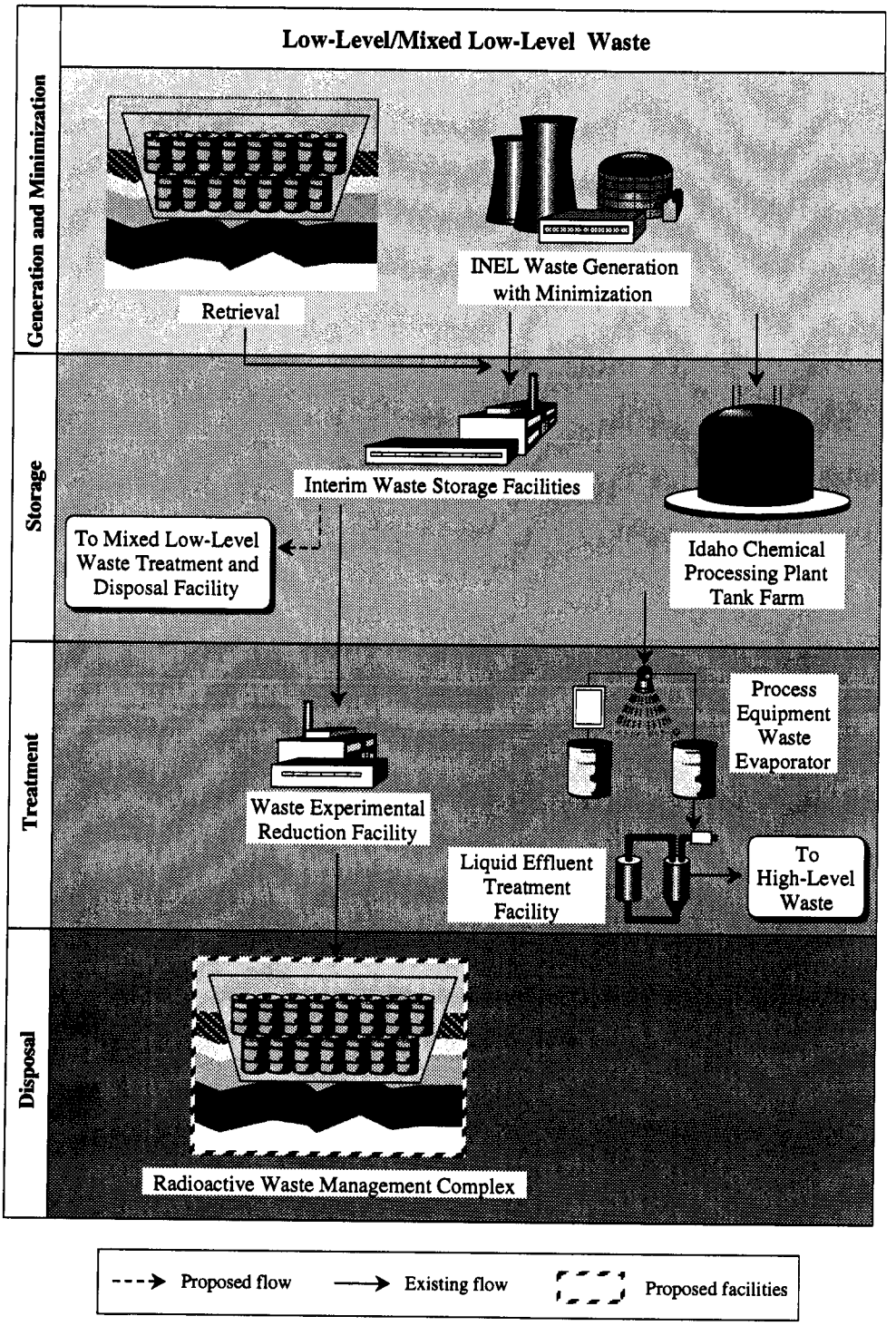



**FIGURE H.2.1–4.**—*Low-Level Waste Management at Idaho National Engineering Laboratory.*




Source: IN DOE 1993a.

2206

**FIGURE H.2.1–5.**—***Mixed Waste Management at Idaho National Engineering Laboratory.***

TABLE H.2.1–1.—*High-Level Waste at Idaho National Engineering Laboratory*

| Waste Matrix | Number of Waste Streams | Inventory as of August 31, 1994 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Inventory Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Remote-handled** | | | | |
| Aqueous liquids/slurries | 1 | 9,040 (1,830,000 gal) | 1 | 3,519 (711,000 gal) |
| Inorganic process residues (calcined solids) | 1 | 4,860 | 1 | 829 |
| **Total Inventory** | 2 | 13,900 | 2 | 4,350 |

Source: DOE 1993b; IN DOE 1994a.

TABLE H.2.1–2.—*High-Level Waste Treatment Capability at Idaho National Engineering Laboratory*

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] ($yd^3$/yr) | Comment |
|---|---|---|---|---|---|
| HEPA Filter Leach Facility | Chemical extraction | HLW remote-handled - alpha, inorganic debris | Concentrated liquid HLW (to calcine), LLW solid | 15 (2,990 GPY) | Under repair. Final RCRA 1990, interim NESHAP 1999 |
| Idaho Chemical Processing Plant Decontamination Facility | Water washing, $CO_2$ decontamination | HLW remote-handled - debris | HLW-RH - solid HLW-remote-handled, LLW liquids | 297 | Operational 1993 |
| Idaho Waste Immobilization Facility | Vitrification | HLW remote-handled - calcine solids | HLW-RH - solid, stabilized | 3,960 | Unapproved, planned |
| New Waste Calcining Facility Evaporator | Evaporation | HLW remote-handled - aqueous liquids | HLW-RH - aqueous liquids | 183,329 (37,032,515 GPY) | Available 2000 interim RCRA 1990 |
| New Waste Calcining Facility | Calcination | HLW remote-handled - aqueous liquid, toxic organic, metals w/mercury | HLW-RH - solid, (calcine) | 6,673 (1,348,030 GPY) | Operational interim (RCRA 1990) |

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1993b; IN DOE 1994a; IN MMES 1993a.

**TABLE H.2.1–3.—*High-Level Waste Storage at Idaho National Engineering Laboratory***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Idaho Chemical Processing Plant Tank Farm | HLW remote-handled - liquid, corrosive, toxic, listed | 17,500 (3,530,000 gal) | Operational; interim RCRA 1990; to be closed |
| New Waste Calcine Facility Tanks | HLW remote-handled - liquid, corrosive, toxic, listed | 337 (68,074 gal) | Operational; staging tanks for calcined feed; interim RCRA 1990 |
| Calcine Solid Storage Facility | HLW remote-handled - solid, toxic, listed (calcine) | 9,305 | Operational; State final permit 1992; RCRA Part B submitted 1994. Permit applications for new storage bins (#8 and #9) to be submitted. |
| FAST Reactor and New Waste Calcine Facility HEPA Filter Storage Facilities | HLW remote-handled - solid, toxic | 217 | Operational; RCRA Part B submitted 1993 |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.
Source: DOE 1993b; IN DOE 1994a; IN MMES 1993a.

**TABLE H.2.1–4.—*Mixed Transuranic Waste at Idaho National Engineering Laboratory***

| Waste Matrix | Number of Waste Streams | Inventory as of August 31, 1994 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Inorganic process residues | 31 | 8,511 | 0 | 0 |
| Contaminated soils/debris | 1 | 50 | 0 | 0 |
| Contaminated debris | 10 | 1,611 | 0 | 0 |
| Contaminated metal debris | 6 | 9,839 | 0 | 0 |
| Inorganic, non-metal debris | 5 | 719 | 0 | 0 |
| Combustible debris | 10 | 728 | 0 | 0 |
| Heterogeneous debris | 25 | 17,699 | 0 | |
| Unknown solids | 9 | 11,502 | 0 | 0 |
| Uncategorized/unknown | 3 | 486 | 0 | 0 |
| **Remote-handled** | | | | |
| Inorganic process residue | 2 | 15 | 0 | 0 |
| Contaminated debris | 1 | 7 | 0 | 0 |
| Heterogeneous debris | 2 | 29 | 1 | 44 |
| Unknown solid | 3 | 9 | 0 | 0 |
| **Total** | 108 | 51,205 | 1 | 44 |

Source: DOE 1994k.

**TABLE H.2.1–5.—*Transuranic and Mixed Transuranic Waste Treatment Capability at Idaho National Engineering Laboratory***

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] ($yd^3/yr$) | Comment |
|---|---|---|---|---|---|
| Idaho Chemical Processing Plant | Water washing | HLW, TRU, LLW, mixed LLW, alpha | HLW, TRU, LLW, mixed LLW | 149 | Operational |
| | HEPA filter leach | HLW, TRU, LLW, Mixed LLW | HLW, TRU, LLW, Mixed LLW | 15 | Existing, plan to use |
| Idaho Waste Processing Facility | Amalgamate, decontaminate, incinerate, encapsulate, size, stabilize, desorb, vitrify | TRU, Mixed TRU, LLW, mixed LLW, alpha, liquid, and solid | Mixed TRU, LLW | 15,810 | Unapproved, planned |
| Liquid Effluent Treatment and Disposal | Factionate, evaporate | TRU, LLW, mixed LLW, alpha | TRU, LLW | 14,376 (2,903,420 GPY) | Operational; RCRA final 1990; NESHAP final and State PSD 1988 |
| New Waste Calcining Facility | Calcify | HLW, TRU, LLW, mixed LLW, alpha, liquid | HLW, TRU, LLW, mixed LLW | 6,556 (1,324,250 GPY) | Operational; RCRA interim 1990 |
| Remote Mixed Waste Treatment | Melt, drain, evaporate | TRU, LLW, alpha | TRU, LLW | 37 | Unapproved, planned |
| Waste Characterization and Storage Facility | Characterize, stabilize, amalgamate, neutralize, adsorb | Alpha mixed TRU, mixed LLW, liquid, and solid | Mixed TRU, mixed LLW, LLW | 392 | Planned, approved, available 1999 |
| Waste Immobilization Facility | Vitrify or stabilize in ceramic | HLW, TRU, LLW, mixed LLW, alpha | HLW, TRU, LLW | 3,960 | Planned, unapproved |

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1993b; IN DOE 1993a; IN MMES 1993a; IN DOE 1994a; INEL 1993a:5.

**TABLE H.2.1–6.—*Transuranic and Mixed Transuranic Waste Storage at Idaho National Engineering Laboratory***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Argonne National Laboratory-West Sodium Storage | Mixed TRU solid | 25 | RCRA Part B submitted 1994 |
| Argonne National Laboratory-West Scrap | Mixed TRU solid | 252 | RCRA Part B submitted 1994 |
| Idaho Chemical Processing Plant HEPA Filters | Mixed TRU solid | 185 | RCRA Part B submitted 1993 |
| Radioactive Waste Management Complex TSA-3 | Mixed TRU solid | 141 | Partial Closure, RCRA Part B submitted 1994 |
| Radioactive Waste Management Complex Waste Storage | Mixed TRU solid | 147,019 | RCRA Part B submitted 1991 |
| Radioactive Waste Management Complex Intermediate-level TRU Storage | Mixed TRU solid | 131 | RCRA Part B submitted 1991 |
| TSA-RE Retrieval Modification Facility | Mixed TRU solid | 122,179 | RCRA Part B submitted 1994 |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: IN DOE 1994a.

TABLE H.2.1–7.—*Mixed Low-Level Waste Streams at Idaho National Engineering Laboratory*

| Waste Matrix | Number of Waste Streams | Inventory as of August 31, 1994 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Aqueous liquids | 12 | 156 (31,500 gal) | 5 | 10 |
| Organic liquids | 17 | 40 (8,080 gal) | 3 | 5 |
| Inorganic process residues | 39 | 4,615 | 8 | 117 |
| Organic process residues | 3 | <1 | 1 | 3 |
| Contaminated soils/debris | 6 | 286 | 1 | 8 |
| Contaminated debris | 11 | 1,990 | 1 | 8 |
| Contaminated metal debris | 12 | 9,353 | 2 | 16 |
| Inorganic non-metal debris | 6 | 459 | 0 | 0 |
| Combustible debris | 13 | 934 | 3 | 8 |
| Heterogeneous debris | 33 | 10,183 | 10 | 183 |
| Labpacks | 8 | 6 | 1 | 1 |
| Reactive metals | 1 | <1 | 0 | 0 |
| Elemental lead | 5 | 544 | 4 | 62 |
| Unknown solids | 6 | 4,191 | 1 | 8 |
| Uncategorized/unknown | 2 | 397 | 0 | 0 |
| Cement forms | 0 | 0 | 1 | 4 |
| **Remote-handled** | | | | |
| Inorganic process residue | 1 | 1 | 0 | 0 |
| Contaminated debris | 1 | 1 | 0 | 0 |
| Heterogeneous debris | 2 | 101 | 1 | 2,616 |
| Reactive metals | 1 | 1 | 0 | 0 |
| Elemental lead | 1 | 71 | 1 | 165 |
| **Total** | 180 | 33,327 | 45 | 3,215 |

Source: DOE 1994k.

TABLE H.2.1–8.—*Mixed Low-Level Waste and Low-Level Waste Treatment Capability at Idaho National Engineering Laboratory* [Page 1 of 2]

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] ($yd^3/yr$) | Comment |
|---|---|---|---|---|---|
| HEPA Filter Leach (CPP-659) | Acid leach | HLW, TRU, mixed LLW-contact-handled, -remote-handled, alpha, solid, debris | LLW solid to RWMC[b], concentrated liquid to tank farm, nonhazardous to sanitary landfill | 15 | Under modification; RCRA final 1990; interim NESHAP to 1999 |
| Idaho Chemical Processing Plant Debris Treatment and Containment | Water wash, $CO_2$, abrasion | HLW, TRU, mixed LLW-contact-handled, -remote-handled alpha, solid, debris | Mixed LLW, HLW, TRU solid, liquid | 297 | Water wash operational, $CO_2$ planned, available 1994 |
| Idaho Waste Processing Facility | Amalgamation, incineration, macroencapsulation, stabilization, thermal desorption, vitrification | Mixed TRU, mixed LLW, contact-handled, remote-handled alpha | Mixed TRU, mixed LLW, LLW solid | 20,677 | Unapproved, planned |
| INEL Waste Treatment, 40 CFR 262.34 | Absorption, neutralization, solidification | Mixed LLW-contact-handled, aqueous liquid, solid, debris | Mixed LLW, LLW | Planned | Operational |
| Liquid Effluent Treatment and Disposal | Fractionation, evaporation | Mixed LLW-contact-handled, remote-handled liquid (PEW evaporator) | Mixed LLW-contact-handled, remote-handled liquid to acid recycle for NWCF, or tank farm | 15,993 (3,230,569 GPY) | Operational; RCRA final 1990; NESHAP final and State PSD 1988 |
| Mixed LLW Treatment Facility | Amalgamation, decontamination, incineration macroencapsulation, neutralization, precipitation, sizing, stabilization | Mixed LLW-contact-handled liquid, solid | Mixed LLW-contact-handled | 525 | Approved, planned |
| New Waste Calcining Facility (CPP 659) | Calcification | Mixed LLW, HLW, mixed TRU-remote-handled liquid | HLW-remote-handled solid | 6,560 (1,320,000 GPY) | Operational; RCRA interim 1990 |
| Portable Water Treatment System | Adsorption, filtration, neutralization | Mixed LLW-contact-handled, aqueous liquid | Mixed LLW | 2,860 (577,000 GPY) | Operational; interim RCRA 1990; renewal 1995 |
| Radioactive Sodium Waste Processing Facility | Steam oxidation | Mixed LLW-contact-handled | Mixed LLW-contact-handled, decontaminated sodium | 911 | Existing, needs modification |

**TABLE H.2.1–8.—*Mixed Low-Level Waste and Low-Level Waste Treatment Capability at Idaho National Engineering Laboratory* [Page 2 of 2]**

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] ($yd^3/yr$) | Comment |
|---|---|---|---|---|---|
| Remote Mixed Waste Treatment | Melt, drain, evaporate | Mixed LLW-remote-handled, alpha | Mixed LLW, remote-handled, alpha | 37 | Unapproved, planned |
| Test Area North 726A Treatment Unit | Ion exchange | Mixed LLW-contact-handled, aqueous liquid | LLW, mixed LLW, nonhazardous liquid | 249 (50,200 GPY) | Operational |
| Tan Cask Dismantlement | Disassembly, recovery | Mixed LLW-contact-handled | Mixed LLW-contact-handled | 16 | Operational |
| Waste Characterization Facility | Neutralization, stabilization, amalgamation, adsorption | Mixed LLW, MTRU, liquid, solid | Mixed LLW, mixed TRU, certified, pre-treated repackaged | Planned | Planned, approved |
| Waste Engineering Development Facility | Amalgamation | Mixed LLW-contact-handled, solid | LLW solid | 0.04 | Planned, approved |
| Waste Engineering Development Facility | Debris sizing | Mixed LLW, LLW-contact-handled, solid | Mixed LLW, LLW solid | 44 | Planned, approved |
| Waste Engineering Development Facility | Neutralization | Mixed LLW-contact-handled | LLW | 3 | Planned, approved |
| Waste Engineering Development Facility | Stabilization | Mixed LLW-contact-handled | LLW | 110<br>2,407 solid | Existing, plan to use |
| Waste Experimental Reduction Facility | Incineration, stabilization, macroencapsulation | Mixed LLW-contact-handled, liquid, solid | LLW, mixed LLW solid to RWMC (stabilized solids and grout) | Input 64,910 (13,111,719 GPY); output 309 grout and 3,617 stabilized solids to RWMC | Operational; interim NESHAP 1987, 1992; RCRA interim 1987, 1992; State final 1992 |
| Waste Immobilization | Vitrification or ceramic fusion | HLW, mixed TRU, mixed LLW solid | HLW solid ceramic | 3,960 | Unapproved, planned |

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

[b] RWMC - Radioactive Waste Management Complex

Source: DOE 1993a; DOE 1993b; IN MMES 1993a; IN DOE 1994a; INEL 1993a:5.

TABLE H.2.1–9.—*Low-Level Waste and Mixed Low-Level Waste Storage at Idaho National Engineering Laboratory*

| Storage Unit | Input Capability | Total Capacity [a] ($yd^3$) | Comment |
|---|---|---|---|
| Argonne National Laboratory-West Sodium Storage | Mixed LLW-TRU | 421 | RCRA Part B submitted 1994 |
| Argonne National Laboratory-West Scrap Storage | Mixed LLW-TRU | 252 | RCRA Part B submitted 1994 |
| Idaho Chemical Processing Plant Fast HEPA Filter Storage | Mixed LLW | 33 | RCRA Part B submitted 1993 |
| Idaho Chemical Processing Plant CPP-1619 Storage | Mixed LLW | 59 | RCRA Part B to be submitted 1995 |
| Idaho Chemical Processing Plant CPP-1617 Staging | Mixed LLW | 667 | RCRA Part B to be submitted 1995 |
| Idaho Chemical Processing Plant New Waste Calcining Facility HEPA Filter Storage | Mixed LLW, TRU | 184 | RCRA Part B submitted 1993 |
| Power Burst Facility Waste Engineering Development Facility Storage | Mixed LLW | 5 | RCRA Part B to be submitted 1995 |
| Power Burst Facility MLLW Storage | Mixed LLW | 59 | RCRA Part B submitted 1993 |
| Power Burst Facility Waste Engineering Development Facility Containment | Mixed LLW | 594 | RCRA Part B to be submitted 1995 |
| Portable Storage at SPERT IV | Mixed LLW | 310 | RCRA Part B submitted 1993 |
| Power Burst Facility Waste Experimental Reduction Facility Storage | Mixed LLW | 361 | RCRA Part B submitted 1993 |
| Radioactive Waste Management Complex TRU Modules | Mixed LLW, alpha LLW, TRU | 147,019 | RCRA Part B submitted 1990, Interim TSCA 1992 |
| Radioactive Waste Management Complex Intermediate-level Storage | Mixed LLW, alpha LLW, TRU | 131 | RCRA Part B submitted 1991 |
| Radioactive Waste Management Complex TSA-RE Retrieval Modification Facility | Alpha LLW, TRU | 122,000 | RCRA Part B submitted 1994 |
| Test Area North 647 Waste Storage | Mixed LLW | 136 | RCRA Part B to be submitted 1995 |
| Test Area North 628 SMC Container Storage | Mixed LLW | 164 | RCRA Part B submitted 1993 |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: IN DOE 1994a.

### H.2.2 Nevada Test Site

Radioactive and hazardous materials have been extracted and analyzed after underground tests. These activities have resulted in the accumulation of low-level, hazardous and mixed wastes which must be treated, stored and disposed. No reactors or reprocessing facilities have operated at NTS. No inventory of spent fuel or HLW has been created, shipped to, or stored at NTS. The *Environmental Restoration and Waste Management Site Specific Plan Fiscal Years 1994-1998* (DOE/NV-336 UC-900) discusses the activities at NTS to achieve full compliance with environmental laws and regulations. The report addresses remediation activities, and the treatment, storage and disposal of current waste generation. *The Site Book for Waste Management* (May 1994) and *The Draft Site Treatment Plan* (August 1994) detail waste management activities at NTS.

Radioactive and hazardous wastes generated from past nuclear testing activities were disposed of at Areas 2, 3, 5, 6, 8, 9, 12, and 23. These were mixed wastes and LLW composed of debris, drilling mud, decontamination wastes, laboratory and classified wastes. Areas 3 and 5 are still currently active for waste treatment, storage and disposal. Area 3 receives offsite and onsite bulk waste for disposal in subsidence craters. A RCRA closure plan has been submitted to the Nevada Division of Environmental Protection for this facility. The Radioactive Waste Management Complex in the north of Area 5 contains the LLW management unit and receives packaged classified and unclassified low-level and mixed wastes. It also has TRU wastes from Lawrence Livermore National Laboratory in storage, and a hazardous waste accumulation site.

Waste disposal in the past at NTS was accomplished through landfills, underground injection and leachfields on NTS and through offsite disposal. NTS has a goal to achieve compliance with environmental laws and regulations and to remove or immobilize hazardous substances, pollutants and contaminants. These activities are expected to result in an acceptable level of environmental restoration for all sites by 2007 (NT DOE 1993d:82). The remedial investigation/feasibility study that will guide this restoration is expected to be completed in 1996.

**Pollution Prevention.** The Nevada Operations Office is an active participant in DOE's national waste minimization and pollution prevention program. A comprehensive waste minimization plan for NTS was completed in 1991, which defines specific goals, methods, responsibility and achievements for organizations. A Waste Minimization Coordinator has been identified to provide a point of contact for NTS waste minimization activities, and a Waste Minimization Task Force has been formed from NTS contractors and users. The management and operations contractor has three full-time employees in its Waste Minimization Project Office, dedicated to promoting waste minimization and pollution prevention, and assuring compliance with DOE Executive orders throughout the site.

Since the initiation of the waste minimization program, several steam-cleaning operations have been eliminated, and half of the hazardous solvents used at NTS have been replaced with nonhazardous solvents. Recycling and reclamation activities have been established to reuse lead, silver, lubricating oil, and trichlorotrifluoroethane. Automatic decontamination equipment, recycling fabrication tool coolant systems, and continuous oil change and reburn systems have been placed in service to reduce hazardous waste generation. Closed loop effluent recycling for steam cleaning has eliminated the production of 4.7 million gallons of wastewater annually, and has reduced hazardous wastes generation by 90 percent. Two solvent waste stills recycle 85 percent of all solvents and thinners used. Nonhazardous aqueous solution parts cleaners have eliminated the need for parts cleaning solvents (NT DOE 1993a:1).

The procurement of all materials is also reviewed for the opportunity to reduce the purchase of hazardous materials for NTS operations. For the future, planning for remediation (i.e., plutonium-contaminated soil cleanup) includes research and development for best available technology consistent with waste minimization goals. In addition, an education and training program for all site personnel and for the surrounding community is helping to increase awareness of best practices and lessons learned in waste reduction.

**Transuranic Waste.** TRU waste is stored at NTS on the TRU Pad Waste Storage in Area 5. This waste

was generated at Lawrence Livermore National Laboratory and shipped to NTS between 1974 and 1990. All NTS mixed transuranic waste is expected to be certified for disposal at WIPP in Carlsbad, NM or another suitable repository should WIPP prove to be unsatisfactory. The Nevada Operations Office is planning to construct a TRU Waste Certification Building for breaching, sampling, and certifying containers of TRU waste to meet the WIPP Waste Acceptance Criteria. However, delays are expected, because the WIPP Waste Acceptance Criteria cannot be finalized until the conditions imposed by EPA (after testing is complete) are known. This waste inventory consists of 800 $yd^3$ of heterogeneous debris (NT DOE 1993f:37). NTS has areas of plutonium-contaminated soil as the result of nuclear weapons tests. The technology for the treatment of these soils is presently being developed. Table H.2.2–1 lists the mixed transuranic waste storage units at NTS.

**Low-Level Waste.** LLW has been generated in the underground testing of nuclear weapons as contaminated soil surrounding the test cavity. Although the debris from a weapons test remains underground by design, samples of this debris are brought to the surface for analysis and then must be disposed of. The majority of LLW generated at NTS is disposed of in subsidence craters in Area 3. This area also receives substantial quantities of containerized bulk waste from other offsite DOE facilities. Some waste disposal units are being closed in this area, while others are being readied for future use. Area 5 receives low-level radioactive waste from both onsite and offsite generators. New disposal capacity is planned for this area, and the offsite generators will be required to meet the NTS waste acceptance criteria (which includes periodic reviews by the Nevada Operations Office) to permit them to ship LLW for disposal at NTS.

Historically, the volume of waste received from offsite is approximately equal to or slightly greater than the volume of waste generated onsite. Onsite waste generation will decline due to cessation of nuclear testing. Remediation activities at NTS will produce waste streams that will have to be treated, stored, and disposed of. Any offsite waste shipments must meet NTS waste acceptance criteria which require that the waste be ready for disposal at NTS. The planning for and progress of remediation activities is described in detail in the *Environmental Restoration and Waste Management Site Specific Plan Fiscal Years 1994-1998*. The LLW disposal capacity in use or planned at NTS is listed in table H.1.1–1.

**Mixed Low-Level Waste.** Mixed LLW is generated by defense program-related support activities, environmental restoration activities, and activities supporting transuranic waste disposal at WIPP or another suitable repository should the WIPP prove to be unacceptable. Wastes were generated by the analytical activities supporting weapons tests and consisted of drilling muds and debris generated from tunnel reentry and rehabilitation. Additional wastes result from radiochemical analysis, and from the decontamination of equipment and facilities used in sample extraction and analysis. NTS has received mixed wastes from other DOE sites and may receive additional waste in the future pending the completion of the Site Treatment Plans for all DOE sites and once proper permits are obtained.

Mixed LLW streams are being characterized to fully determine what technologies and capabilities are required for safe, environmentally sound and compliant disposal. Nine waste streams at the NTS require additional characterization before a formal determination of whether the waste is mixed can be made. Currently, the Nevada Operations Office is planning to build the Liquid Waste Treatment System, a central facility for treating contaminated effluents from environmental restoration and defense programs activities. The Liquid Waste Treatment System would be comprised of double-lined receiving/holding tanks, evaporation reservoirs, process equipment for chemical separation of solids, and a batch plant to provide sludge/sediment stabilization through cementation. Receiving/holding and evaporation reservoirs and associated mixed waste processes will be RCRA-permitted.

Table H.2.2–2 lists mixed LLW storage and disposal facilities at NTS. Table H.2.2–3 lists the mixed LLW streams inventory and 5-year projected generation at NTS. Table H.2.2–3 does not include nine potential mixed waste streams which are awaiting further characterization and evaluation. The total volume is 350 $yd^3$ including a 45,000-pound empty spent shipping cask. The 7,500 $yd^3$ of projected mixed wastes from environmental activities are also not included due to

lack of characterization. Table H.2.2–4 lists mixed LLW treatment facilities at NTS.

**Hazardous Waste**. Hazardous wastes are generated from ongoing operations at NTS. Wastes consist of solvents, lubricants, fuel, lead, metals, and acids. Hazardous wastes are accumulated at various sites around NTS while they await shipment offsite to a RCRA-permitted facility. Over the next 5 years, additional satellite storage locations are planned. A separate accumulation site across the road from Area 5 is provided to avoid potential cross-contamination with radioactive waste. The generation of hazardous wastes at NTS is expected to decrease significantly because of the cessation of nuclear testing, the completion of environmental restoration activities, and because of the impact of waste minimization activities. Hazardous waste accumulation capacity in Area 5 is approximately 1,500 $yd^3$ (NT REECO 1994a:11).

**Nonhazardous Waste**. Nonhazardous sanitary wastes are expected to be generated at the current rates for several years into the future, then decline due to the cessation of nuclear weapons testing. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities.

**TABLE H.2.2–1.—*Mixed Transuranic Waste Storage at Nevada Test Site***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Asphalt Storage Pad (covered building) | Mixed TRU solid | 1,485 | Available storage capacity on the TRU Pad to be used for storage of future, on-site generated mixed LLW that does not meet RCRA LDR provisions. |

[a] Schedules and capacity for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: NT DOE 1994a.

**TABLE H.2.2–2.—*Low-Level and Mixed Low-Level Waste Storage and Disposal Capacity at Nevada Test Site***

| Disposal Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Mixed Waste, P03U Management Unit | Mixed LLW solid | 155,532 | Nonoperational. RCRA Part A 1988. EA published, withdrawn. Will be considered in site-specific EIS. |
| LLW Disposal, P04U | LLW solid, wood, metal, rubble, debris | 87,565 | Operational. Additional 801,300 $yd^3$ capacity available for expansion |
| LLW Disposal, P06U | LLW solid | 35, 318 | Operational, reserved for future use |
| Classified Shallow Land Burial, T02C | LLW solid, metal, solidified liquid in approved containers | 2,220 | Operational–No remaining capacity |
| Shallow Land Burial, T03U | LLW solid, metal, debris, unclassified, solidified liquid | 9,268 | Reserved for LLW disposal |
| Classified Shallow Land Burial, T04C | LLW solid, metal, solidified liquid in approved containers | 1,985 | Operational |
| Mixed Waste Storage Pad | Mixed LLW solid | Planned | Planned. RCRA Part B submitted in 1992 |
| Bulk LLW Disposal, U3AHAT | LLW solid, wood, metal, solidified liquid, soil, biological | 558,869 | Operational |

[a] Schedules and capacity for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: DOE 1992f; DOE 1993c; NT REECO 1994a.

TABLE H.2.2–3.—*Mixed Low-Level Waste Streams at Nevada Test Site*

| Waste Matrix | Number of Waste Streams | Inventory as of August 31, 1994 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Organic process residues | 1 | 0.1 | 0 | 0 |
| Scintillation vial | 1 | 0.3 | 0 | 0 |
| Lead acid area 15 spent batteries | 1 | 0.1 | 0 | 0 |
| **Total** | 3 | 0.5 | 0 | 0 |

Source: NT DOE 1994a.

TABLE H.2.2–4.—*Mixed Low-Level Waste and Low-Level Waste Treatment Capability at Nevada Test Site*

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity ($yd^3$ per year) | Comment |
|---|---|---|---|---|---|
| Liquid Waste Treatment System | Separation, evaporation, stabilization | Mixed LLW liquids and slurries | LLW solid | 29,700 (6,000,000 GPY) | Now in Title I design; in the current design, RCRA organics cannot be accepted |

Source: NT DOE 1994a.

### H.2.3 Oak Ridge Reservation

ORR consists of three operating industrial complexes in and around the city of Oak Ridge. The Energy Systems Waste Management Organization provides the waste management oversight for ORR. It also provides guidance to each of the operating facility waste management divisions which are responsible for operating and managing their respective waste management facilities and activities.

**Y-12 Plant.** Laboratory, maintenance, construction, demolition, and cleanup activities; machining operations; and waste produced in the purification of uranium for recycle are the primary waste generation activities at the Y-12 Plant (Y-12). In addition, metal-plating operations generate plating waste solutions while various laboratory activities generate reactive wastes and waste laboratory chemicals. Liquid process waste and the sludge resulting from the treatment of these process wastes are generated throughout the plant. Waste oils and solvents are generated from machining and cleaning operations. Daily operations such as janitorial services and floor sweepings generate both noncontaminated and uranium-contaminated industrial trash.

*Pollution Prevention.* The Y-12 Pollution Prevention Awareness Program Plan describes the overall program in detail. The program is designed to maintain the flow of information pertaining to waste minimization and pollution prevention and to facilitate activities to implement real reductions in waste generation. A summary description of the four key elements of the Waste Minimization and Pollution Prevention Program includes a promotional campaign, information exchange, a waste tracking system, and waste assessment performance.

One goal of the program is to sustain an effective pollution prevention effort by improving the awareness of the employees of waste minimization opportunities and activities. Improved awareness is accomplished in many ways including training, posters, publications, seminars, promotional campaigns, and recognition of individuals and teams for activities that reduce waste generation. Waste minimization activities at other ORR sites and other weapons sites provide useful input to the program. Using ideas developed by others is an important aspect that can save time and resources.

Tracking waste generation in a manner that lends itself to waste minimization reporting is a prerequisite to documenting successes or failures in waste minimization efforts. Y-12 is improving its ability to record and track waste shipments. Process waste assessments are being conducted as part of the ongoing program to identify, screen, and analyze options to reduce the generation of waste. This determines the amount of material in a workplace that is disposed of as waste during work operations. The assessment provides a summary of hazardous materials usage and waste production and identifies those processes and operations that need to be improved or replaced to promote waste minimization.

*Spent Nuclear Fuel.* Y-12 does not generate any spent nuclear fuel; however, it does store and safeguard a small amount of reactor-irradiated nuclear material in Building 9720-5. It is a large warehouse facility containing numerous vaults for storage. Some features of the facility are classified and it is distinguished by its high level of security. Operations consist of transfers, storage, and inventory of highly enriched uranium (HEU) in containers of various types.

*High-Level Radioactive Waste.* Y-12 does not generate or manage HLW.

*Transuranic Waste.* Y-12 does not generate or manage TRU waste.

*Low-Level Waste.* Machining operations which use stock materials including steel, stainless steel, aluminum, depleted uranium, and other materials produce machine turnings and fines as waste products. Waste treatment provides controlled conversion of waste streams generated from operations to an environmentally acceptable, or to a more efficiently handled or stored, form. This activity includes continuing operation and maintenance of facilities that treat wastewaters and solid waste generated from production and production support activities. Waste minimization and planned treatment facilities are expected to reduce the magnitude of these wastes. In 1992, Y-12 treated approximately 128,000 gallons of liquid LLW and 170 $yd^3$ of solid LLW (OR DOE 1993b:9-3). Table H.2.3–1 summarizes the LLW treatment facilities at

Y-12 of which the major facilities are described below.

The Uranium Chip Oxidation Facility thermally oxidizes depleted and natural uranium (less than 1 percent enrichment) machine chips under controlled conditions to a stable uranium oxide. Upon arrival, chips are weighed, placed into an oxidation chamber, and ignited. The oxide is transferred into drums and transported to the Uranium Oxide Storage Vaults. The Uranium Chip Oxidation Facility is not designed to treat uranium sawfines. Hence, sawfines are currently blended with uranium oxide and placed in the Oxide Vaults as a short-term treatment method.

The Waste Feed Preparation Facility processes and prepares solid LLW for volume reduction by an outside contractor or storage at Y-12. The facility utilizes a 200-ton capacity baler to reduce the waste volume to one-eighth of its original size. Waste comes to the facility from areas known to generate contaminated material, or from dumpsters that were analyzed at the Trash Monitoring Station and deemed to be above the radioactive acceptability limits for the sanitary landfill. The compacted bales are placed in DOT-approved metal boxes and staged in an adjacent warehouse prior to offsite shipment for incineration or storage at Y-12.

The Uranium Treatment Unit is located near Building 9206 and is used to treat uranium-contaminated nitrate waste solutions which are generated in enriched uranium recovery operations in Buildings 9212 and 9206. After the waste is processed through the Uranium Treatment Unit, it is transferred to the Y-12 Waste Management Division for storage, further treatment, and/or final disposal.

The Waste Coolant Processing Facility is a biodegradation and storage facility for waste coolants that may be LLW and utilizes the following equipment for coolant treatment:

- Three storage tanks;
- Feed tank;
- Waste processing reactor/clarifier;
- Sludge holding tank;
- Two sludge blenders/dryers;
- Effluent holding tank; and
- Transfer pumps.

Microorganisms biodegrade approximately 30,000 gallons of waste coolant per month into harmless products. Each batch of coolant takes approximately 30 days to treat. After treatment, the clarifier separates the wastes into three process streams: floating oily solids, liquid effluent, and settled biological solids. Floating solids are dewatered in the dryer/ribbon blender and are transferred to drums. Liquid effluent is sent to the Central Pollution Control Facility or West End Treatment Facility/West Tank Farm for final treatment prior to NPDES discharge. Biological solids are further treated in the aeration tank and are then recycled or sent through the blender for dewatering. Nonrecycled solids are currently pumped into tankers for storage. This practice will continue until adequate treatment and disposal methods are established.

Long-term storage options include storage in warehouses, tanks, and vaults, as well as storage of Y-12 wastes in buildings at K-25. The major Y-12 LLW storage facilities, described below, are summarized in table H.2.3–2. In 1992, approximately 600 $yd^3$ of LLW and 1,330 $yd^3$ of uranium-contaminated scrap metal was stored at Y-12 (OR DOE 1993b:9-6).

The Classified Waste Storage Facility will provide storage for Y-12 classified wastes contaminated with radionuclides. These wastes are currently being stored by the waste generators. The facility will meet plant security requirements for classified waste management and guidelines for the management of LLW and mixed LLW. The Classified Waste Storage Facility is equipped with a baler for volume reduction and shape-changing capabilities, but the baler will not become operational until the ventilation and fire-suppression systems are upgraded to meet health, safety, and fire protection requirements. Funding for this facility upgrade has not yet been made available. Wastes will be monitored by Health Physics personnel. The facility is located in Building 9720-25.

Buildings 9206 and 9212 containerized waste storage units provide for the storage of cans of ash resulting from the combustion of uranium-contami-

nated solid wastes. Combustible solid wastes contaminated with enriched uranium are ashed during the uranium recovery process. The resulting cans of ash are stored in buildings 9206 and 9212 containerized storage units until uranium accountability results have been obtained and the material can be returned to the uranium recovery process for further processing to recover the enriched uranium.

The Building 9720-25 classified containerized waste storage unit provides for the permitted storage of RCRA hazardous waste and mixed LLW, which is classified for national security purposes under provisions of the *Atomic Energy Act.* Waste is stored in this unit awaiting further processing, treatment, or ultimate disposal.

The Depleted Uranium Oxide Storage Vaults I and II are located on Chestnut Ridge northeast of Building 9213. The vaults are constructed of reinforced concrete and provide a retrievable storage repository for uranium oxide, uranium metal, and a blended mixture of uranium sawfines and oxide. The vaults contain a negative pressure exhaust system that operates during material entry. The exhaust is filtered and monitored prior to its release to the atmosphere. The facility utilizes forklift trucks, electric hoists, and a motorized drum dumper during operation. Depleted uranium oxide and blended sawfines are delivered in sealed 30- and 55-gallon drums. The containers have a weight limit of 850 pounds.

The Old Salvage Yard contains both low-level uranium-contaminated and nonradioactive scrap metal. However, most scrap currently sent to this facility is contaminated. The Contaminated Scrap Metal Storage is an area within the Old Salvage Yard that is used to store uranium-contaminated scrap metal. Contaminated scrap is being placed in B-25 boxes and eventually will be transferred to the above-grade storage pads. Noncontaminated scrap is sold when offsite shipments are allowed. This facility is located at the west end of Y-12.

Y-12 has no current onsite LLW disposal capability. All disposal activities at the Bear Creek Burial Ground were terminated on June 30, 1991. This landfill was used to dispose of radiologically-contaminated solid waste. These wastes are currently containerized and stored at Y-12 in above-grade storage pads or are shipped offsite for incineration. In 1992, approximately 220 $yd^3$ of solid nonmetallic LLW were sent offsite to be incinerated with the ash returned to Y-12 for storage (OR DOE 1993b:9-5). The Low-Level Waste Disposal Facilities project will provide new disposal facilities at a new centralized location of the ORR. The Low-Level Waste Disposal Facilities will utilize state-of-the-art disposal technologies, including lined trenches with leachate collection treatment capabilities and tumulus confinement disposal units. The Class-II facility, for wastes contaminated with very low concentrations of long half-life radionuclides, is expected to be operational in 1998. DOE has indefinitely postponed construction of the Class-I facility, for wastes contaminated with low concentrations of predominantly short half-life radionuclides.

*Mixed Low-Level Waste.* Mixed LLW is generated from the development, metal preparation, fabrication, and assembly/industrial engineering functions at Y-12. Mixed LLW are hazardous wastes such as solvents, degreasers, biodegradable coolants, organic and inorganic acids, biodenitrification sludge, and wastewater that are contaminated with enriched and/or depleted uranium. There is no disposal of mixed waste at Y-12; however, future plans include disposal of mixed wastes at a permitted offsite commercial facility. Mixed wastes are put in storage awaiting treatment, treated at Y-12, or sent to another ORR facility for treatment. Table H.2.3–3 presents the inventory of mixed LLW at Y-12 as of December 31, 1992 along with a 5-year projection. In 1992, approximately 354,000 gallons of liquid mixed LLW was treated at Y-12 (OR DOE 1993b:9-3). The Y-12 Waste Management Division operates several mixed LLW treatment facilities which are described below and were previously summarized in table H.2.3–1.

The Groundwater Treatment Facility treats wastewater from the Liquid Storage Facility and seepwater collected at K-25 to remove volatile and nonvolatile organic compounds and iron. It is part of the Disposal Area Remedial Action program to collect and treat contaminated groundwater from the Bear Creek Burial Grounds. The Groundwater Treatment Facility is located at the far west end of Y-12, adjacent to the West End Treatment Facility. This facility utilizes an air stripping operation to remove volatile organics. In addition, carbon adsorption eliminates nonvolatile organics and PCBs . Iron removal equipment is also operational. After treat-

ment, wastewater is sampled and recycled if additional processing is required. Wastewater that meets discharge specifications is pumped into East Fork Poplar Creek through an NPDES monitoring station. The Groundwater Treatment Facility treated and discharged approximately 300,000 gallons during 1991.

The West End Treatment Facility/West Tank Farm treats the following nitrate-bearing wastes generated by Y-12 production operations: nitric acid wastes; nitrate-bearing rinsewaters; mixed acid wastes; waste coolants; mop water; caustic wastes; and biodenitrification sludges. Treatment operations consist of biological denitrification, biological oxidation, metals precipitation, coagulation, flocculation, clarification, filtration, pH adjustment, degassification, and carbon adsorption. Wastes are received at the West End Treatment Facility/West Tank Farm in 5,000-gallon tankers, 600-gallon polytanks, and in smaller, approved waste transportation containers such as drums, bottles, and carboys. Detailed waste analysis documentation is used to determine the treatment scheme and temporary storage location of each shipment. The West End Treatment Facility Effluent Polishing System facilitates the removal of uranium, trace metals, and suspended solids. The treated wastewater is then discharged to East Fork Poplar Creek through an NPDES monitoring station. Sludges, spent carbon, and spent filter material generated during the treatment processes are currently stored in 500,000-gallon tanks. A major modification to the West End Treatment Facility/West Tank Farm is currently in the design phase. This modification will remove all heavy metals up front, thus separating the hazardous sludge from the nonhazardous sludge. Approximately two-thirds of the current sludge volume generated can then be disposed of as nonhazardous wastes.

In 1992, approximately 450 $yd^3$ of mixed LLW including PCB and uranium waste were stored at Y-12 (OR DOE 1993b:9-6). Table H.2.3–2 summarized the mixed LLW storage facilities at Y-12 which are described below.

The Containerized Waste Storage Area consists of three concrete pads covering approximately 25,000 $ft^2$. These pads provide storage for LLW, RCRA hazardous, and mixed LLW. An impermeable dike surrounds each pad to provide one foot of spill containment. Fire protection at this facility is currently being upgraded.

The Building 9811-1 RCRA Storage Facility (OD7 and OD8) contains a diked storage area for tanks (OD7) and an enclosed storage area for containers (OD8) with a capacity of 1,000 drums. The OD7 contains four 30,000-gallon tanks, one 10,000-gallon tank, two 3,000-gallon tanks, associated piping and pumps, and an oil/water separator. RCRA waste oil/solvent mixtures containing various concentrations of chlorinated and nonchlorinated hydrocarbon solvents, uranium, trace PCBs, and water for specific chemical constituents are stored at OD8 in 55-gallon drums and 300-gallon Tuff-tanks to await sampling and analytical results. Wastes deemed compatible with OD7 materials are pumped into those tanks. Noncompatible wastes are transported to different facilities.

The Waste Oil/Solvent Storage Facility (OD9) is a permitted RCRA/TSCA hazardous waste storage facility. It consists of a diked area supporting five 40,000-gallon tanks, a tanker transfer station with five centrifugal transfer pumps, and a drum storage area. Three tanks house PCB wastes contaminated with uranium, one tank contains non-radioactive PCB wastes, and one tank holds RCRA hazardous wastes. Likewise, a diked and covered pad furnishes space for 35 drums. Wastes assigned to this facility are first stored at OD8 (Building 9811-1 RCRA Storage Facility) to await laboratory results. The diked area contains additional space for a sixth 40,000-gallon tank. This facility is projected to be used until 2010, due to the anticipated lack of disposal outlets for uranium-contaminated organic liquids.

The Liquid Organic Waste Solvent Storage Facility (OD10) contains four 6,500-gallon and two 3,000-gallon stainless steel tanks for storage of ignitable nonreactive liquids, including those contaminated with PCBs and uranium. In addition, a diked and covered storage area provides space for 1,000 drums of material. The facility is capable of segregating various spent solvents for collection and storage. Major solvent waste streams are transferred to tanks until commercial resale, disposal, or incineration at K-25 takes place.

Building 9720-9 Storage Area supplies a drum storage area for mixed and/or PCB wastes, including an area designed to contain flammable wastes. The western half, which contains space for approximately 1,500 drums, stores both PCB and RCRA hazardous waste. However a diking upgrade is planned to allow for the handling of RCRA materials. The facility's eastern half is not currently in use. Upgrades to the ventilation, diking, and fire-suppression systems will comply with RCRA, TSCA, and DOE standards and will allow for mixed and PCB waste storage. The design of these modifications is complete, and construction will begin when NEPA documentation has been submitted and approved.

The RCRA Staging and Storage Facility (Building 9720-31) prepares solid, liquid, and sludge wastes for offsite shipment. The facility consists of seven storage rooms and seven staging rooms, each with a separate ventilation system. The staging rooms house small containers that are packed with compatible materials and shipped. The storage rooms hold larger containers, such as 55-gallon drums. Each room, which can hold up to 90 drums, accommodates a different class of hazardous waste.

The RCRA and PCB Container Storage Area (Building 9720-58) is a warehouse facility utilized for staging prior to treatment of PCB-contaminated equipment (transformers, capacitors, and electrical switchgear) and nonreactive, nonignitable RCRA waste contaminated with uranium. Waste containers received at Building 9720-58 include 30- and 55-gallon drums, 330- and 660-gallon portable tanks, B-25 boxes, and self-contained PCB equipment.

The Solid Storage Facility provides 17,500 $ft^2$ of storage space for PCB- and uranium-contaminated soil. The facility also contains a synthetic liner for leachate collection and a leak detection system. Collected leachate is transferred to the Liquid Storage Facility for pretreatment. The Solid Storage Facility is currently undergoing the RCRA Part B permitting process. No additional wastes are being added to the facility.

*Hazardous Waste.* Plating rinsewaters; waste oil and solvents from machining and cleaning operations; contaminated soil, soil solutions, and soil materials from RCRA closure activities; and waste contaminated with hazardous constituents from construction/demolition activities are the major sources of hazardous waste. In 1992, approximately 150,300 gallons of hazardous liquid were treated (OR DOE 1993b:9-3). In addition 419,900 gallons of liquid leachate from the Bear Creek Burial Ground were processed. The Y-12 Waste Management Division operates several hazardous treatment facilities that are described below and are summarized in table H.2.3–4.

The Central Pollution Control Facility process consists of several batch operations that treat wastewaters delivered in 5,000-gallon tankers and 600-gallon polytanks. Approximately 800,000 gallons of treated effluent from the Central Pollution Control Facility/Plating Rinsewater Treatment Facility were discharged during 1991.

The Y-12 Cyanide Treatment Unit provides storage and treatment of waste solutions containing metallic cyanide compounds from spent plating baths and precious metal recovery operations. The cyanide reduction process performed within the unit is currently performed in 55-gallon containers, although plans are under way to discontinue this method of treatment and initiate use of fixed tanks for use in the treatment process. After waste is treated at the Cyanide Treatment Unit, it is transferred to the West End Treatment Facility for further treatment and discharged to the East Fork Poplar Creek.

The Plating Rinsewater Treatment Facility treats dilute plating rinsewaters contaminated primarily with chromium, copper, nickel, and zinc. In addition, the facility can treat cyanide-bearing wastes and remove chlorinated hydrocarbons. In 1991, the Plating Rinsewater Treatment Facility treated 283,504 gallons of plating rinsewater. The facility is located across the street from the Building 9401-2 Plating Shop, which produces most of Y-12's rinsewaters. The facility neutralization, equalization, and cyanide destruction equipment is located outdoors in a diked basin. The remainder of the facility process is located in Building 9623. Rinsewaters are received via a direct pipeline from the Plating Shop. In addition, rinsewaters may be received in tankers, polytanks, or in any acceptable waste shipping container. The Plating Rinsewater Treatment Facility performs the following treatment operations: pH adjustment; flow equalization; heavy metal removal by electrochemical precipitation; flocculation; clari-

fication; carbon adsorption; and filtration. After the clarification operation, the rinsewater is transferred to the Central Pollution Control Facility. The Central Pollution Control Facility provides the carbon adsorption operation, final filtration, and discharge to East Fork Poplar Creek through an NPDES monitoring station. Treated rinsewater is sometimes recycled for use as make-up water for Central Pollution Control Facility processes. Sludge from the clarification process is transferred to the Central Pollution Control Facility and then taken to the West Tank Farm for interim storage.

Hazardous waste is being stored until Martin Marietta Energy Systems and DOE approve shipment for offsite disposal under the DOE "No Rad Added" performance objective (OR DOE 1993a:9-11). In 1992, approximately 260 $yd^3$ of hazardous waste and 60 $yd^3$ of PCB wastes were placed in storage at Y-12 (OR DOE 1993b:9-6). Table H.2.3–5 summarizes the major existing Y-12 hazardous waste storage facilities described below.

The Oil Landfarm Soil Storage Facility contains approximately 550 $yd^3$ of soil contaminated with PCBs and volatile organics. The soil was excavated from the Oil Landfarm and Tributary 7 in 1989. The soil is contained in a covered, double-lined concrete dike with a leak-detection system. The leak-detection system will soon be modified to enhance detection capabilities.

The Liquid Storage Facility of the Disposal Area Remedial Actions Liquid Storage Treatment Unit is a hazardous waste storage facility built during the Bear Creek Burial Ground closure activities. It is located in Bear Creek Valley approximately two miles west of Y-12. It collects and stores groundwater and other wastewaters received from the Seep Collection Lift Station, the Solid Storage Facility, tankers, polytanks, and the diked area rainfall accumulation. Feed streams may contain oil contaminated with PCBs, volatile and nonvolatile organic compounds, and heavy metals. Processing and storage equipment include:

- Two 75,000-gallon bulk storage tanks;
- 6,000-gallon oil storage tank;
- Gravity separator;
- Filtering unit;
- Composite sampling station; and
- Tanker transfer station.

The wastewater travels through the gravity separator, cartridge filters, and composite sampling station prior to storage in the bulk tanks. A reinforced concrete dike surrounds all equipment to provide spill containment. After sufficient wastewater accumulates in the bulk storage tanks, it is processed at the Groundwater Treatment Facility. A new leachate collection system collects and pumps hazardous waste seepage from the burial ground to the Liquid Storage Facility.

In 1992, approximately 7,900 gallons of liquid hazardous waste from Y-12 was incinerated offsite (OR DOE 1993b:9-5). Other hazardous waste is sent offsite to commercial vendors or other ORR sites.

The Y-12 Waste Management Division operates the Sanitary and Industrial Landfill II which provides special waste disposal including asbestos materials, aerosol cans, materials contaminated with beryllium oxide, glass, fly ash, coal pile runoff sludge, empty pesticide containers, and Steam Plant Wastewater Treatment Facility sludge. The landfill area is located on Chestnut Ridge near the eastern end of the plant and serves Y-12, Oak Ridge National Laboratory, K-25, and other DOE prime contractors in Oak Ridge. The landfill utilizes shallow land burial by the large trench method and is permitted by the State of Tennessee. Requests are filed with the state to provide disposal for additional materials as needed.

The Chestnut Ridge Borrow Area Waste Pile (Industrial Waste Landfill III) consists of mercury-contaminated soil removed from the Oak Ridge Civic Center area and deposited at Y-12 Chestnut Ridge. No further disposal at this site has been made. Closure of this waste pile was initiated after a complete soil analysis following state sampling regulations was completed.

*Nonhazardous Waste.* Major waste-generating activities include construction and demolition activities that produce large volumes of noncontaminated wastes, including lumber, concrete, metal objects, soil, and roofing materials. Industrial trash is generated by daily operations throughout the plant.

These operations include janitorial services, floor sweepings in production areas, and production activities. In 1992, about 375,700 gallons of wastewaters from the Central Pollution Control Facility and the Plating Rinsewater Treatment Facility and 37,860,000 gallons of wastewaters from the Steam Plant were processed. In addition, approximately 280,700 gallons of other liquid nonhazardous waste was treated. The Waste Storage Facility in Building 9720-25 has solid waste baler with an 8:1 compaction ratio (DOE 1994n). Approximately 1,970 $yd^3$ of solid nonhazardous waste was compacted during 1992 (OR DOE 1993b:9-3).

The Steam Plant Wastewater Treatment Facility treats approximately 40 million gallons per year of wastewater from steam plant operations, demineralizers, and coal pile runoff. Treatment processes include wastewater collection/sedimentation, neutralization, clarification, pH adjustment, and dewatering. The treatment facility utilizes automated processes for continuous operation. All solids generated during treatment are nonhazardous and are disposed of in the sanitary landfill. The treated effluent is monitored prior to NPDES discharge to the East Fork Poplar Creek. The Y-12 Utilities Department manages this facility. Lake Reality is a lined containment basin with a surface area of about 2 acres. The pond serves to enhance the water quality of East Fork Poplar Creek downstream of Y-12.

The Sludge Handling Facility (T-118) was designed and constructed to provide water filtration and sludge dewatering in support of a storm sewer cleaning and relining project. Filtered water was reused by the sewer-cleaning contractor, and the dewatered sludge was stored in specially constructed containers for future disposal. The facility is currently being used to store containers of LLW.

The Steam Plant Ash Disposal Facility is used to collect, dewater, and dispose of sluiced bottom ash generated during operation of the coal-fired steam plant. An additional trench was constructed for the disposal of sanitary and industrial wastes generated by Oak Ridge National Laboratory, K-25, and Y-12. In order to comply with environmental regulations for landfill operations, the Steam Plant Ash Disposal Facility includes a leachate collection system, a transfer system to discharge the collected leachate into the Oak Ridge public sewage system, groundwater monitoring wells, and a gas migration/ventilation system. The landfill, Industrial Landfill V, is permitted to dispose of approximately 4 million cubic feet per year of industrial waste. The facility was designed and is operated in accordance with Tennessee solid waste disposal regulations and became operational in March 1994.

In 1992, approximately 1,100 $yd^3$ of clean scrap metal was stored at Y-12 (OR DOE 1993b:9-6). The salvage yard is used for the staging and public sale of nonradioactive, nonhazardous scrap metal. Sales have been suspended, however, until procedures to meet the DOE "No Rad Added" performance objective have been approved. The New Salvage Yard provides accumulation and sorting activities for nonradiologically contaminated scrap metal. Plans are in place to provide an automotive lead cell battery repository for used batteries until recycling options are initiated. This facility is located near the Bear Creek Burial Ground. Construction debris is buried at Landfill VI and VII on Y-12.

**Oak Ridge National Laboratory**. Because Oak Ridge National Laboratory is a research facility, it has many diverse waste-generating activities, each of which may produce only a small quantity of waste. Isotope production, utilities, and support functions such as photography are additional sources of waste. The radioactive wastes produced by each activity at Oak Ridge National Laboratory reflect the nature of its operation. A large number of radioisotopes are handled, in isotope production and packaging, in reactor and accelerator operations, in reprocessing studies on nuclear fuel, and in investigations into the interactions of radioactivity with living systems. The radioactive wastes generated by these activities can be classified as follows:

- Concentrates generated by the treatment of intermediate-level wastes, which are disposed of by hydrofracture;

- LLW contaminated with beta/gamma emitting radioactivity. These wastes, which have a low surface dose rate, are compacted if possible and disposed of in earthen trenches; those wastes which exhibit a high surface dose rate are disposed of in augered holes;

- TRU wastes, which are retrievably stored; and

- Low-level alpha-emitting wastes, which are evaluated for criticality hazards before disposal in augered holes.

*Pollution Prevention.* Waste segregation is used to minimize the generation of solid LLW. By providing collection barrels for both radioactive and nonradioactive wastes, the volume of wastes that requires handling as radioactive waste has been reduced. Before these procedures were implemented, radioactive and nonradioactive wastes were discarded in the same barrel. This contaminated the nonradioactive portion and required special disposal of an inflated amount of waste.

*Spent Nuclear Fuel.* Oak Ridge National Laboratory generates small quantities of spent nuclear fuel. Several facilities described below are used to house spent nuclear fuel (DOE 1993r:28-29).

Radiochemical Development Facility (Building 3019). The Radiochemical Development Facility was built in 1943 and contains secure storage wells, hood and glovebox laboratories, shielded remote processing cells, and shielded hot cells. It serves as the national repository for U-233. The fuel is contained in dry wells; plans call for its continued storage there.

Irradiated Fuels Examination Laboratory (Building 3525). The Irradiated Fuels Examination Laboratory only contains hot cells. Disassembly and examination of irradiated fuel and components continue to be the mission of the facility.

High Level Radiochemical Laboratory (Building 4501). The High Level Radiochemical Laboratory contains centrally located hot cells supported by various laboratories capable of handling radioactive material. It has been used in performing work on fission gas release in light water reactor fuel rods. The spent nuclear fuel is in dry storage.

Radiochemical Engineering Development Center (Building 7920). The Radiochemical Engineering Development Center is a multipurpose hot cell facility with the appropriate equipment, shielding, and containment provisions to safely process and store large quantities of highly radioactive fuel elements. It was specifically built to prepare and process targets for the High Flux Isotope Reactor.

Radiochemical Engineering Development Center (Building 7930). This facility is a heavily shielded hot cell facility designed for remote operation using master-slave manipulators. It is being used to develop and demonstrate methods for remote processing of irradiated thorium-based fuel and to fabricate the recovered materials into fuel suitable for reuse in a power reactor.

Bulk Shielding Reactor. This pool-type research reactor is currently shut down with the core stored in racks. Fuel assemblies from the Oak Ridge Research Reactor are also stored in the pool.

High Flux Isotope Reactor. The High Flux Isotope Reactor is an 85 megawatt (MW), beryllium-reflected, light-water-moderated, flux-trap-type research reactor with associated support equipment and a storage pool. Missions include production of isotopes for medical and industrial applications, neutron-scattering experiments, and various material irradiation experiments. This is the only reactor that is still generating fuel elements that will need storage in the future.

Molten Salt Reactor Experiment. The Molten Salt Reactor Experiment is an 8 MW, homogeneous reactor consisting of uranium fluoride fuel in molten lithium salt. Its purpose was to test the practicality of a molten-salt reactor concept for central power station applications. The fuel is being stored in the salt storage tanks beneath the reactor.

Tower Shielding Reactor. The Tower Shielding Reactor is a reactor facility where experiments were conducted outdoors on a remote hilltop. It is a spherically symmetric 1 MW plate-type reactor. The purpose of the facility was to conduct large-scale experiments to test shielding design methods and obtain associated data. The original core is located in the reactor. Four fuel plates are stored in the underground site, and 1,200 low-enriched fuel pins are stored in DOT shipping containers.

7823A/7827/7829 Wells. These shielded, retrievable storage facilities are stainless-steel dry wells placed in the ground but are currently closed to further

storage. The wells were used to store irradiated fuel and associated fission products from 1972 to 1989.

Homogeneous Reactor Experiment Wells. Seven augered holes were drilled in 1964 to store 135 gallons of a 40-molar fuel solution. Each well was filled to ground level with soil and marked by a concrete plug and brass plaque.

Classified Burial Ground. This area is now closed to operations but in the past, fuel materials were buried there. The exact quantity and location of all this material is not known.

A summary table of the inventory of reactor-irradiated nuclear material is shown in table H.2.3–6.

*High-Level Radioactive Waste.* Oak Ridge National Laboratory does not generate or manage HLW.

*Transuranic Waste.* Table H.2.3–7 presents the inventory of mixed TRU wastes at Oak Ridge National Laboratory as of December 31, 1992 along with a five-year projection. The bulk of Oak Ridge National Laboratory's mixed TRU waste is in three liquid/sludge waste streams that are stored in tanks at the present time. Each of these tank's wastes must be remotely-handled because of the high radioactivity. Oak Ridge National Laboratory's Underground Storage Tank management program includes implementation of leak detection, corrosion protection, spill and overflow protection, annual tightness testing, operational controls, record keeping, reporting, and replacement of those systems that cannot be upgraded by 1998. The program also addresses the immediate removal from service and remediation of sites with tanks found to be leaking, and it implements any required closures, corrective actions, and any upgrading and/or replacement of affected tanks in accordance with the regulatory requirements. Status of the tanks managed under the Underground Storage Tank Program through 1991 is as follows:

- Twenty-six tanks have been excavated or permanently taken out of service (twenty approved by Tennessee as closed while six require additional investigation and/or corrective action before final closure approval).
- Twenty-four tanks are deferred from 40 CFR 280 regulations. These will be taken out of service or upgraded.
- Two tanks were upgraded in 1990 to meet the current leak detection requirements.
- Two tanks contain heating oil and are excluded from regulation under 40 CFR 280.
- Five tanks contain waste oil contaminated with radionuclides and are excluded under 40 CFR 280.

Solid TRU waste consisting of filters, paper, metals, and other items is generated at Oak Ridge National Laboratory through laboratory, pilot plant, and reactor operations. This includes both contact-handled and remote-handled TRU waste contaminated with lead and, in some cases, mercury. There is no treatment of TRU wastes at Oak Ridge National Laboratory. TRU wastes generated at Oak Ridge National Laboratory are being placed in retrievable storage. Contact-handled TRU waste is packaged predominantly in drums, while remote-handled TRU waste is packaged in concrete casks. In 1992, approximately 3 $yd^3$ of contact-handled and 2 $yd^3$ of remote-handled TRU waste were placed in storage (OR DOE 1993b:9-7). Current activities center around certification of contact-handled waste, planning and designing of a repackaging and certification facility for remote-handled wastes, and planning for shipment of wastes to WIPP or another suitable repository should WIPP prove to be unsatisfactory. The repackaging facility, which is in Building 7880, is called the Waste Handling and Packaging Plant and is planned for 2001. Table H.2.3–8 summarizes the storage capability for TRU and mixed TRU wastes at Oak Ridge National Laboratory.

*Low-Level Waste.* Isotope production and research activities generate a variety of low-level radioactive wastes to include low-level wastewater. Sources of solid LLW include contaminated equipment, filters, paper, rags, plastic, and glass, and sludge from the Process Waste Treatment Plant. Table H.2.3–9 shows the LLW treatment facilities that are operating. Solid LLW to include radioactive scrap metal is placed in storage prior to disposal. In 1992, approximately 884

$yd^3$ of solid LLW, 27 $yd^3$ of radioactive scrap metal, and 24 $yd^3$ of PCB-contaminated LLW were placed in storage awaiting disposal (OR DOE 1993b:9-7). Table H.2.3–10 lists the LLW and mixed LLW storage facilities currently operating at Oak Ridge National Laboratory.

The area designated as SWSA 6 is the only onsite disposal unit at Oak Ridge National Laboratory. It receives solid LLW, including radioactively-contaminated asbestos. In 1992, approximately 131 $yd^3$ of radioactive sanitary waste, 56 $yd^3$ of radioactive scrap metal, and 39 $yd^3$ of radioactively-contaminated asbestos was buried at SWSA 6 (OR DOE 1993b:9-4). Table H.2.3–11 lists the LLW disposal units at SWSA-6.

*Mixed Low-Level Waste.* Because Oak Ridge National Laboratory is a research facility, it has many diverse waste-generating activities, each of which may produce only a small quantity of waste. Isotope production, utilities, and support functions such as photography are additional sources of waste. Mixed wastes are generated by research projects and some facility operations. Isotope production and research activities generate a variety of mixed low-level and mixed TRU wastes. Table H.2.3–12 presents the inventory of mixed LLW at Oak Ridge National Laboratory as of December 31, 1992, along with a five-year projection.

As shown in table H.2.3–9 three facilities are currently treating mixed waste at Oak Ridge National Laboratory: the Process Waste Treatment Plant, the Liquid Low-Level Waste Evaporation Facility, and the Melton Valley Low-Level Waste Immobilization Facility (OR DOE 1993a:9-21). One other treatment facility at Oak Ridge National Laboratory, the Nonradiological Wastewater Treatment Plant, is operating and could be used to treat mixed waste.

The Nonradiological Wastewater Treatment Plant is designed to reduce pollutant concentrations in nonradiological wastewaters including hazardous wastes to levels acceptable for effluent discharge. The plant operates in a continuous mode and involves physical and chemical processing steps. The facility contains a heavy-metal removal system, where the pH of the wastewater is raised to 10.5 in a clarifier. Polymers are added to induce flocculation and settling of the metal precipitates. The wastewater is passed through a filtration system to remove particulates. An air stripper then removes volatile organics and activated carbon columns remove mercury.

The Process Waste Treatment Plant is designed to treat process wastewaters, groundwater, and evaporator condensate wastewaters that contain low levels of radioactivity. Small concentrations of radioactive materials have occasionally been processed. Process wastewaters may contain small quantities of radionuclides, metals, anions, and organic chemicals. Under normal operating conditions, the Process Waste Treatment Plant can process wastewater at a rate of 130 gallons per minute (gpm). The design capacity is 200 gpm. Wastewaters can contain organic materials and low levels of radioactivity. The facility can treat waste streams with some heavy metals but not streams containing PCBs.

The Liquid Low-Level Waste Evaporation Facility treats liquid LLW using evaporation. It operates in a semicontinuous mode; waste is accumulated in collection tanks and transferred through underground piping to an evaporator system. The design capacity is 28,000 gallons per day (GPD). The facility processes an average of 300 gallons of liquid wastes per day under normal operating conditions. The facility can treat waste streams containing organic contaminants.

The Melton Valley Low-Level Waste Immobilization Facility is used to solidify liquid mixed LLW that has a pH greater than 12.5 and that contains some heavy metals. This liquid mixed LLW is transferred from tanks by interconnecting pipelines. Batches of waste are pumped from a liquid decantation system to a solidification system as required to provide adequate storage-tank capacity. The facility operates only on a campaign basis to provide adequate storage capacity. Solidification is currently performed using cementation. Design capacity is 16,500 gallons of liquid waste per month. Under normal operating conditions, the facility can process 2,000 gallons per month as required to provide adequate storage-tank capacity. The facility cannot treat HLW, alpha-contaminated waste with TRU activity levels greater than 100 nanocuries per gram (nCi/g), organic wastes, or PCBs.

A summary of the mixed LLW storage facilities at Oak Ridge National Laboratory is shown in table

H.2.3–10. An estimate of the capacity of these facilities is also given. In 1992, approximately 11 $yd^3$ of mixed waste were placed in storage at Oak Ridge National Laboratory (OR DOE 1993b:9-7).

The only disposal of mixed waste done at Oak Ridge National Laboratory is the burial of radioactive asbestos at SWSA-6. Asbestos contaminated with low-levels of radioactivity is placed in silos. In 1992, approximately 39 $yd^3$ of contaminated asbestos were buried (OR DOE 1993b:9-4). Low-level contaminated biological waste has also been buried at SWSA-6.

*Hazardous Waste.* Hazardous wastes are generated in laboratory research, electroplating operations, painting and maintenance operations, descaling, demineralizer regeneration, and photographic processes. Few hazardous wastes are treated in onsite facilities. Onsite treatment at Oak Ridge National Laboratory includes elementary neutralization and detonation facilities. A summary of the hazardous waste treatment facilities at ORNL is shown in table H.2.3–13. In 1992, approximately 1,720 gallons of liquid hazardous wastes were treated at the Nonradiological Wastewater Treatment Plant and about 130 gallons of hazardous waste were evaporated (OR DOE 1993b:9-3).

The Chemical Detonation Facility treats small amounts of wastes that would be dangerous to transport offsite. Explosives such as aged picric acid are detonated in the detonation facility. Certain other wastes (e.g., spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport are shipped to offsite RCRA-permitted commercial treatment/disposal facilities.

In 1992, approximately 58 $yd^3$ of hazardous waste and 31 $yd^3$ of PCB waste were stored at Oak Ridge National Laboratory (OR DOE 1993b:9-7). PCB wastes are managed in storage facilities until they can be shipped offsite for treatment and/or disposal. PCB-contaminated and/or hazardous wastes are temporarily stored at Building 7507, and PCB-contaminated wastes are stored on the 7507W Storage Pad. Due to the "No Rad Added" policy, hazardous wastes are being stored as mixed waste. A listing of the hazardous waste storage facilities at Oak Ridge National Laboratory is shown in table H.2.3–14. Approximately 17 $yd^3$ of asbestos wastes were sent offsite to the Y-12 Sanitary and Industrial Landfill II. About 20 $yd^3$ of hazardous and PCB wastes were sent to K-25 for storage and incineration in the TSCA Incinerator (OR DOE 1993b:9-5).

*Nonhazardous Waste.* Nonhazardous wastes result from Oak Ridge National Laboratory maintenance and utilities. The steam plant and the sanitary waste treatment plant produce a sludge that is sampled to demonstrate that it is nonhazardous and meets the Y-12 Industrial and Sanitary Landfill II waste acceptance criteria. Scrap metals are discarded from maintenance and renovation activities and are recycled when appropriate. Construction and demolition projects also produce nonhazardous industrial wastes. All solid nonhazardous wastes and medical wastes after they are autoclaved to render them noninfectious except scrap metal are sent to the Y-12 Industrial and Sanitary Landfill II. Approximately 27 $yd^3$ of scrap metal were placed in storage at Oak Ridge National Laboratory in 1992 until it is definitely characterized as nonradioactive per the "No-Rad Added" policy (OR DOE 1993b:9-7).

**K-25 Site.** Enrichment, maintenance, decontamination, and research and development activities have generated a wide variety of waste at K-25. Because of its past uranium enrichment mission, uranium is the predominant radionuclide found in K-25 waste streams. Waste management activities are increasing. Low-level radioactive wastes from other DOE sites are being placed in building vaults until a final disposition strategy is identified. Also, PCB wastes and RCRA wastes contaminated with uranium began arriving from other DOE sites in 1987 for incineration in the K-1435 TSCA Incinerator. Tables H.2.3–15 and H.2.3–16 summarize the storage and treatment facilities at K-25 that are capable of storing and treating multiple categories of waste.

*Pollution Prevention.* K-25 policy mandates minimization of waste generated while achieving compliance with applicable environmental regulations. Five waste reduction options are used at K-25: segregation, material substitution, process innovation, mechanical volume reduction, and recycling/reuse. In recent years, some aluminum cans, worker clothing, and office furniture have been recycled for use at K-25. Such recycling has saved approximately 2,500,00 lb of materials as of 1991. K-25 manage-

ment supports the waste reduction program. An example of this program is the conversion to gas-fired boilers to reduce opacity excursions and, in effect, reduce or eliminate fly ash production.

*Spent Nuclear Fuel.* K-25 does not generate or manage spent nuclear fuel.

*High-Level Radioactive Waste.* K-25 does not generate or manage HLW.

*Transuranic Waste.* K-25 does not generate or manage TRU waste.

*Low-Level Waste.* Solid LLW is generated by discarding radioactively-contaminated construction debris, wood, paper, asbestos, trapping media, and process equipment and by removing radionuclides from liquid and airborne discharges. Currently, solid LLW is being stored for future disposal. Table H.2.3–17 shows the storage facilities that deal only with LLW. Specifics on some of the storage facilities are described below. Treatment of the current inventory of contaminated scrap metal at K-25 (as well as at Portsmouth, Paducah, and Fernald facilities) is expected to occur over the next 3 to 5 years as part of a comprehensive DOE Scrap Metal Program to be managed through K-25. All contaminated scrap metal is stored aboveground at the K-770 scrap metal facility until further disposal methods are evaluated.

The Uranium Hexafluoride Cylinder Program is directed toward improving the safety and reliability of long-term storage for 7,000 cylinders currently at K-25. These cylinders remain from the now-terminated gaseous diffusion mission. In storage at the site are approximately 5,000 10-ton and 14-ton cylinders of depleted uranium hexafluoride; 1,000 cylinders of normal-assay feed uranium hexafluoride; 400 cylinders containing more than 50 pounds of "enriched" material; and 600 miscellaneous empty cylinders. The Uranium Hexafluoride Cylinder Program is being designed to develop a clear understanding of the current conditions of the cylinders and define any near-term and long-term actions for safe storage of the cylinders pending decisions on ultimate disposition of the uranium hexafluoride material. Some of the initial actions in the program are a baseline inspection, a corrosion coupon program, and an ultrasonic thickness measurement program. The baseline inspection identified a variety of cylinder defects which will require special attention and also identified four breached cylinders. Immediate corrective actions have been taken to handle the breached cylinders and a schedule of activities has been developed for moving and repairing the cylinders.

The cylinders containing normal-assay feed uranium hexafluoride are currently being shipped to the Paducah Gaseous Diffusion Plant. The current DOE direction for the 5,000 cylinders with depleted uranium hexafluoride is to store them until at least the year 2020, at which time conversion to oxide will be performed if no other uses have been determined. A plan for cleaning the cylinders containing more than 50 lb of enriched material and empties has not yet been approved (this may be performed at K-25 or at one of the operating gaseous diffusion plants).

Currently, there are no onsite disposal facilities being operated at K-25. Energy Systems Waste Management Organization has been established and assigned the responsibility to design, construct, and operate all new LLW disposal facilities for the ORR. This organization is physically located at K-25.

*Mixed Low-Level Waste.* Mixed LLW primarily consists of contaminated waste oils, solvents, sludges, soils, and acid wastes. Table H.2.3–18 presents the inventory of mixed LLW as of December 31, 1992 along with a 5-year projection. Sludges contaminated with low-level radioactivity were generated by settling and scrubbing operations and were stored in K-1407B and K-1407C ponds. Sludges have been removed from these ponds, and a portion have been fixed in concrete at the K-1419 Sludge Treatment Facility and stored above ground at the K-1417 Drum Storage Yard. These materials are considered mixed LLW; however, a delisting petition has been submitted to EPA. Disposition of this waste is pending a determination of this petition.

Most of the treatment of mixed waste is at the TSCA Incinerator and the Central Neutralization Facility. The majority of waste treated at the TSCA Incinerator cannot be treated by commercial incinerators because of radioactive contamination. All waste sent to this facility must be fully characterized and identified. DOE has an approved chain-of-custody system for all waste received from offsite. The K-1435 TSCA Incinerator is capable of inciner-

ating waste that is mixed or that contains PCBs. In 1990, a limited amount of waste was incinerated as a part of the startup testing. The incinerator began full operations in early 1991 and met all regulatory requirements in processing 1,310 $yd^3$ of mixed waste. Mixed TSCA waste is being generated in the ash residue at the TSCA Incinerator. Compliance issues regarding the management of the mixed PCB and radioactive waste generated in the ash are being pursued with EPA by DOE.

Most of the radioactively-contaminated wastewater treated at the Central Neutralization Facility is generated at the TSCA Incinerator from the wet scrubber blowdown. Treated effluents are discharged through a designated release point. The contaminated sludges that precipitate in the sludge-thickener tank are stored in an approved above-ground storage area at K-25.

RCRA mixed, radioactive land disposal restricted waste (including some nonradiological classified land disposal restricted waste) has been stored in some areas for longer than 1 year (OR DOE 1993a:9-26). These wastes are currently subject to the land disposal restriction that permits storage only for accumulation of sufficient quantities to facilitate proper treatment, recycling, or disposal. This waste is being stored because of the nationwide shortage of treatment and disposal facilities for these types of waste. Private-sector technology demonstrations are being conducted that involve uranium extractions from sludge.

Uranium-contaminated PCB wastes (i.e., mixed wastes) are being stored in excess of the 1-year limit imposed by TSCA because of the lack of treatment and disposal capacities. DOE and EPA have signed a Federal Facility Compliance Agreement, effective February 20, 1992, to bring the facility into compliance with TSCA regulations for use, storage, and disposal of PCBs. It also addressed the approximately 10,000 pieces of nonradioactive PCB-containing dielectric equipment associated with the shutdown of diffusion plant operations.

In 1989, during routine inspections of the drums of stabilized K-1407 Pond sludge at the K-1417 Storage Facility, it was discovered that many of the drums had begun to corrode. Free liquid (waste with a pH of 12) on top of the concrete in the drums was found to be causing the corrosion (OR DOE 1993a:9-16). An action plan has been implemented to decant and/or dewater the mixed waste contained in the drums. A total of 45,000 drums of stabilized material and 32,000 drums of raw sludge must be processed and moved to storage facilities that meet regulations governing mixed wastes. Of these 77,000 drums, 10,000 are currently stored in K-25 vaults and 67,000 are located at the K-1417A and K-1417B Drum Storage yards. It is planned that all containers will be transferred to and stored in new and existing facilities, the K-1065 site and K-31 and K-33 buildings, respectively.

*Hazardous Waste*. Hazardous wastes generated at K-25 include PCB articles and items, waste oils and items, and uncontaminated asbestos waste. All hazardous wastes are managed according to applicable state and Federal regulations and DOE orders. Several waste management facilities are already in place. Changing laws and regulations have made it necessary to upgrade several facilities and to design and construct new facilities that reflect the most recent environmental technology. The Central Neutralization Facility and the TSCA Incinerator are the two major facilities that treat hazardous waste.

The Central Neutralization Facility provides pH adjustment and chemical precipitation for several aqueous streams throughout K-25. The main purpose of the Central Neutralization Facility is to treat wastewater to ensure compliance with the requirements of NPDES discharge limits on pH, heavy metal concentrations, and suspended solids. The treatment system consists of two 25,000-gallon reaction tanks and a 60,000-gallon sludge-thickener tank. Acidic wastes are neutralized with a hydrated-lime slurry, and basic wastes are neutralized with sulfuric or hydrochloric acid. The hydrated lime bin and acid tanks are located at the facility. The treatment facility is physically divided into two distinct sections for treating both hazardous and nonhazardous waste streams.

The TSCA Incinerator consists of storage tanks, dikes, and the incinerator. The incinerator system consists of a liquid, solid, and sludge feed system; a rotary kiln incinerator; and a secondary combustion chamber. The wastes treated at this facility include oils, solvents, chemicals, sludges, and aqueous waste.

In general, most of the waste stored at K-25 is designated as hazardous waste which has been contaminated with PCBs. Recyclable materials such as mercury and silver-bearing photographic wastes are stored before recycling, while other hazardous wastes are stored until sufficient quantity is accumulated for an offsite shipment. All offsite disposals of hazardous wastes were halted in 1991 until procedures addressing a DOE performance objective of "No Rad Added" were developed by the sites and approved by DOE Headquarters. Incineration is the preferred method for offsite treatment or disposal of wastes, particularly PCB wastes; however, landfills and other types of disposal are used as needed. In 1992, 290 $yd^3$ of asbestos were placed in the Y-12 landfill.

*Nonhazardous Waste.* Computer paper is being recycled from the K-25 Computer Technology Center. The program for recycling paper is being reviewed for expansion into nonradiological areas. Product substitutions at the paint shop and photography lab have resulted in a decrease of waste generation. No percentage of reduction has been calculated due to the lack of baseline data.

Waste assay monitors have been purchased and are being used to screen solid, potentially radioactive waste to determine the potential to manage it as a nonhazardous waste. The K-770 clean scrap yard provides storage for nonradioactive scrap metal. The scrap metal is stockpiled before being sold to the public. The solid nonhazardous waste from K-25 is sent to the Y-12 Industrial and Sanitary Landfill II. Some materials such as furniture, file cabinets, and paper are sold through property sales. The only nonhazardous treatment facility at K-25 is the sanitary waste treatment plant. The sanitary sludge is disposed of in the Y-12 landfill.

**TABLE H.2.3–1.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Y-12* [Page 1 of 2]**

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity[a] ($yd^3$ per year) | Change |
|---|---|---|---|---|---|
| Biodenitrification Unit (Bldg. 9818) | Neutralization pH adjustment nitrate removal | Liquid mixed LLW (nitrate solutions from enriched uranium recovery) | Biosludge to West End Treatment Facility | 1,500[b] (300,000 GPY) | |
| Central Pollution Control Facility | Filtration carbon adsorption, oil/water separation, and sludge dewatering | Liquid LLW, mixed LLW, and hazardous waste (nonnitrate liquid wastes) | Treated wastewater discharged through NPDES outfall and solids to West Tank Farm | 9,900[c] (2,000,000 GPY) | Final NPDES permit May 1, 1990. Permit only allows 28,000 gallons in three days. Includes 4,930 $yd^3$ of hazardous waste treated. |
| Cyanide Treatment Facility (Bldg. 9201-SN) | Chemical oxidation, pH adjustment | Liquid mixed LLW and hazardous waste (cyanide spent plating batches) | Wastewater to West End Treatment Facility | 33 (6,600 GPY) | Interim RCRA status September 29, 1992. |
| Liquid Storage Facility (Bldg. 9416-35) | Oil/water separation by filter cartridges | Liquid mixed LLW (leachate from certain capped burial grounds in Bear Creek Valley) | Stored liquids to Groundwater Treatment Facility and PCB-laden oil to TSCA incinerator | 12,400[d] (2,500,000 GPY) | Also a storage unit. Amount of mixed LLW treated is approximately 4,300 $yd^3$/yr. |
| Depleted Uranium Oxidation Facility | Calcination | Solid mixed LLW (uranium fines) | Uranium oxide to depleted uranium oxide storage vaults | Design feedrate is classified. | Scheduled construction startup in 1996. |
| Groundwater Treatment Facility (Bldg. 9616-7) | Carbon absorption and air stripping | Liquid mixed LLW (Liquid Storage Facility groundwater) | Groundwater air stripper effluent, spent carbon, and sludge to depleted uranium oxide storage vaults and liquid effluent through NPDES outfall | 12,400[d] (2,500,000 gal/hr) | Final NPDES permit May 23, 1990 and RCRA permit submitted January 31, 1990. Amount of mixed LLW treated is approximately 4,300 $yd^3$/yr. |
| Interim Reactive Waste Treatment Area | Open burning | Solid LLW (sodium-potassium waste) | Treated residue waste to depleted uranium oxide storage vaults and treated waste to K-25 | Campaign 2 times per year, 8 hours per campaign, 15 GPD | State air permit submitted September 29, 1992 and RCRA permit submitted January 31, 1990. Interim facility awaiting completion of Reactive Waste Treatment Facility. Design feedrates 0.9 $yd^3$/yr. |
| Mercury Treatment Facility | Metal precipitation, filtration, carbon absorption | Mercury contaminates from wastewater treatment stream | Wastewater effluent discharged via NPDES. Solids require further treatment at another facility | 130,000 (26,300,000 GPY) | Planned, but unapproved. Anticipated that treatment rate limited to 50 gpm. |
| Oak Ridge Reservation Mixed Waste Treatment Facility | Thermal desorption, decontamination, stabilization, and sorting | Liquid and solid mixed LLW | | Planned | Scheduled for 2004. |

**TABLE H.2.3–1.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Y-12* [Page 2 of 2]**

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity[a] ($yd^3$ per year) | Change |
|---|---|---|---|---|---|
| Plating Rinsewater Treatment Facility (Bldg. 9623) | Cyanide destruction, filtration, pH adjustment, electrochemical chrome reduction, and carbon adsorption | Liquid mixed LLW (nonnitrate bearing plating rinsewaters) | Treated wastewater discharged through Central Pollution Control Facility NPDES outfall and solids to West Tank Farm | 40,000 (8,000,000 GPY) | Design feedrate is 12 $yd^3$/hr. Final RCRA and NPDES permit January 1, 1990. NPDES permit does not allow more than 30,000 gal in three days. |
| Production Waste Treatment Facility Phase II | Decontamination, incineration, and neutralization | Solid mixed LLW (demolition waste, noncombustible LLW, and incinerator ash, mixed waste sludges, and mixed waste soils) | | 8,650 | Planned and available October 1, 2000. Design feedrate is 1.4 $yd^3$/hr. Hours in operation is estimated to be 6,000 hours. |
| Uranium Chip Oxidation Facility | Incineration | Solid LLW (depleted and normal uranium chips) | Uranium oxide to depleted uranium oxide storage vaults | Classified yearly treatment | Final state air permit expires January 1, 1994 and final NPDES permit approved January 22, 1987. Design feedrate is 2,200 lbs/hr. |
| Uranium Recovery Operation (Bldg. 9206, 9272) | Leaching, filtration, dissolution, oxidation, evaporation, extraction | Metal and organic removal from aqueous stream, aqueous neutralization, purification for recycle | All waste diverted to Bioidentification Unit | 1,500[b] (300,000 GPY) | System is exempt from permitting requirements under agreement with the State Same capacity as Biodenitrification Unit. |
| Uranium Treatment Unit (Portable) | Filtration and precipitation | Liquid mixed LLW (uranium-contaminated organic solvents) | Organic waste to TSCA Incinerator at K-25 | 2 $yd^3$/day (500 GPD) | Unit has been decommissioned and is in standby mode. |
| Waste Coolant Processing Facility (Bldg. 9983-78) | Extended activated sludge treatment, sludge drying | Liquid LLW (contaminated waste coolants) | Oily solids to dewatering and drums, biological solids to dewatering, and liquid to Central Pollution Control Facility or West End Treatment Facility/West Tank Farm | 990 (200,000 GPY) | Also a storage unit. May be capable of treating of mixed LLW. |
| Waste Feed Preparation Facility (Bldg. 9401-4) | Compaction | Compactible solid LLW | Compacted solid LLW to Y-12 Sludge Handling Pad | 24,800 | An exemption for the state air permit has been granted. Design feedrate is 30 $yd^3$/hr. Intermittant operation at 8 hours/day and 2 days/week |
| West End Treatment Facility (Bldg. 9616-7) | Absorption, anaerobic digestion, clarification, coagulation, filtration, flocculation, and precipitation | Liquid mixed LLW and hazardous waste (radioactive-contaminated and nonradioactive nitrate waste) | Liquid effluent through NPDES outfall | 10,900 (2,200,000 GPY) | Final NPDES permit September 30, 1990 and interim RCRA status January 31, 1990. Design capacity is 2,700,000 GPY). Currently operating but with modification being constructed by April 30, 1995. |

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

[b] Annual capacity based on reported capacity 1,000 gallons per day assuming 300 days per year.

[c] Normal capacity ranges from 1,350,000 to 2,000,000 GPY.

[d] Annual capacity based on reported capacity of 2 gal/min assuming 24-hour operation 300 days per year.

Source: DOE 1993h; DOE 1994k; DOE 1994n; OR DOE 1994a; OR MMES 1993f.

TABLE H.2.3–2.—*Low-Level and Mixed Low-Level Waste Storage Capability at Y-12* [Page 1 of 2]

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| 9811-1 Tank Storage Unit (OD-7) | Liquid and solid hazardous (beryllium)- mixed LLW | 671 (135,000 gal) | RCRA permit submitted January 23, 1992. Mostly oils and solvents which are not flammable are stored. Wastes are not considered PCB wastes, but may contain beryllium |
| Above Grade Storage Pads | Solid LLW | 9,300 | Available September 30, 1992. Above ground storage of low-level until Low-Level Waste Disposal Facility |
| Alpha-4 Container Storage Area | Solid mixed LLW (Old shutdown process waste) | 1,970 | RCRA permit submitted January 31, 1990. One area of building being modified for 95 $yd^3$ of storage. |
| (Bldg. 9404-7) | Solid PCB and uranium contaminated waste | 135 | Storage of liquid and/or hazardous waste not permitted except for PCB waste. Capacity for 496 drums. As of August, 1994 10$yd^3$ is available for storage |
| Buildings 9206 and 9212 | LLW and Mixed LLW | 26 | Part B permit |
| Building 9720-9 Storage Area | LLW and mixed LLW | 1,290 (260,000 gal) | Part B permit. As of August 1994 approximately 520 $yd^3$ of LLW and mixed LLW stored. Hazardous waste in table H.2.3–5. |
| Building 9825-1 and 2 oxide vault | LLW | 1,340 | |
| Classified Waste Storage Area (Bldg 9720-25) | Solid LLW and mixed LLW | 825 | Part B permit. Estimated that inventory is approximately 670 $yd^3$ as of August 1994. |
| Container Storage Facility (Bldg. 9720-12) | Solid mixed LLW | 133 | RCRA permit submitted January 31, 1990 |
| Contaminated Scrap Metal Storage Yard (part of Old Salvage Yard) | Solid mixed LLW (uranium-contaminated scrap). | 3600 | Estimated that inventory is approximately 240 $yd^3$ as of August 1994 |
| Cyanide Treatment Facility | Cyanide spent plating batches, mixed LLW | 11 (2,240 gal) | Interim RCRA status September 27, 1992. Also treatment facility for hazardous and mixed wastes. |
| DARA Solid Storage | Solid mixed LLW | 6,620 | Facility full as of August 1994. |
| Depleted Uranium Oxide Storage Vaults | Solid LLW (depleted uranium oxide and metal) | 2,370 | Two vaults of reinforced concrete |
| East Chestnut Ridge Waste Pile | Solid mixed LLW (contaminated soil and spoil from closure of RCRA units) | 1,200 | RCRA permit submitted January 31, 1990. Facility in full as of August 1994 |
| Liquid Organic Waste Storage (Bldg. 9720-45, OD-10) | Liquid and solid mixed LLW. Ignitable nonreactive and radioactive waste. Can also include hazardous waste | 52 (10,600 gal)[b] | RCRA permit submitted December 1, 1991. A diked and covered storage area for 120 drums of material |
| Liquid Organic Waste Storage Tank 600A (Bldg. 9720-45, OD-10) | Liquid hazardous (corrosive) waste and mixed LLW | 15 (3,000 gal) | RCRA permit submitted January 31, 1990 |
| Liquid Organic Waste Storage Tank 600B (Bldg. 9720-45, OD–10) | Liquid hazardous (corrosive) waste and mixed LLW | 15 (3,000 gal) | RCRA permit submitted January 31, 1990 |
| Liquid Organic Waste Storage Tank 700A (Bldg. 9720-45, OD-10) | Liquid mixed LLW (uranium-contaminated gasoline and diesel) | 32 (6,500 gal) | RCRA permit submitted December 1, 1990 |
| Liquid Organic Waste Storage Tank 700B (Bldg. 9720-45, OD-10) | Liquid mixed LLW (uranium-contaminated rinsewaters) | 32 (6,500 gal) | RCRA permit submitted December 1, 1990 |

**TABLE H.2.3–2.—*Low-Level and Mixed Low-Level Waste Storage Capability at Y-12* [Page 2 of 2]**

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Liquid Organic Waste Storage Tank 900A (Bldg. 9720-45, OD–10) | Radioactive rinsewater. | 32 (6,500 gal) | RCRA permit submitted December 1, 1990 |
| Liquid Organic Waste Storage Tank 900B (Bldg. 9720-45) | Radioactive liquid solvents and organics | 32 (6,500 gal) | RCRA permit submitted December 1, 1990 |
| OD-8/Container Warehouse (Bldg. 9811-1) | Liquid and solid hazardous - mixed LLW | 530 (106,000 gal) | RCRA permit submitted January 23, 1992 |
| Oil Land Farm Storage | Contaminated scrap metal | 6,200 | Facility in full as of August 1994 |
| PCB, Shed (Bldg. 9720-58) | Solid LLW and mixed LLW (PCB-contaminated waste included) | 250 | Part B permit |
| RCRA and PCB Container Storage Area (Bldg. 9720-58) | Solid mixed LLW | 630 | RCRA permit submitted January 23, 1992 |
| RCRA Staging Area (Bldg. 9720-31) | Liquid and solid mixed LLW and hazardous waste | 220 (45,000 gal) | RCRA permit submitted January 31, 1990 |
| RCRA Storage Facility (OD7-Bldg. 9811-1) | Liquid mixed LLW (spent oil and solvents) | 740 (150,000 gal) | RCRA permit submitted January 31, 1990 |
| Solid Storage Facility | Solid mixed LLW and hazardous waste to include PCB-contaminated waste | 4,000 $yd^2$[c] | RCRA permit submitted January 31, 1990. Contains 4,000 $yd^3$ waste pile contaminated with radioactivity. |
| Waste Oil/Solvent Storage Facility I (Bldg. 9811-8) | Liquid mixed LLW (including PCBs) and hazardous waste | 17 (3,400 gal) | RCRA permit submitted December 1, 1991. No reactives or ignitables. Interim storage until containers can be emptied into tanks. |
| Waste Oil/Solvent Storage Facility II (Bldg. 9811-8) | Liquid mixed LLW (including PCBs) and hazardous waste | 200 (40,000 gal) | RCRA permit submitted December 31, 1991. No reactives or ignitables. Material has been shipped to TSCA incinerator. |
| Waste Oil/Solvent Storage Facility IV (Bldg. 9811-8) | Liquid and solid mixed LLW (including PCBs) and hazardous waste | 200 (40,000 gal) | RCRA permit submitted December 1, 1991. No reactives or ignitables. Material has been shipped to K-25 TSCA incinerator. |
| Waste Oil/Solvent Storage Facility V (Bldg. 9811-8) | Liquid mixed LLW (including PCBs) and hazardous waste | 200 (40,000 gal) | RCRA permit submitted January 31, 1990. No reactives or ignitables. Material has been shipped to K-25 TSCA incinerator. |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

[b] Also included in hazardous waste storage facility table.

[c] Facility provides 1,940 $yd^2$ of storage space for PCB and uranium-contaminated soil.

Source: DOE 1994n; OR DOE 1993a; OR DOE 1994a; OR MMES 1993f.

**TABLE H.2.3–3.—*Mixed Low-Level Waste at Y-12***

| Waste Matrix | Number of Waste Streams | Inventory as of December 31, 1992 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Aqueous liquids | 10 | 4 (880 gal) | 6 | 6 (1,200 gal) |
| Organic liquids | 42 | 450 (90,000 gal) | 35 | 870 (176,000 gal) |
| Inorganic solids | 25 | 6,500 | 15 | 820 |
| Organic solids | 23 | 55 | 14 | 130 |
| Soils | 8 | 8,400 | 4 | 40 |
| Metal and inorganic debris | 1 | 60 | 1 | 0.4 |
| Combustible debris | 41 | 120 | 29 | 310 |
| Reactive metals | 5 | 1 | 4 | 5 |
| Beryllium waste | 1 | .003 | None | None |
| Batteries | 1 | 2 | 1 | 10 |
| Other | 22 | 20 | 10 | 12 |
| **Total** | 179 | 15,600 | 119 | 2,200 |

Source: DOE 1994k; OR DOE 1994a.

**TABLE H.2.3–4.—*Hazardous Waste Treatment Capability at Y-12***

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity[a] | Comment |
|---|---|---|---|---|---|
| Central Pollution Control Facility | Filtration, carbon adsorption, oil/water separation, and sludge dewatering | Liquid hazardous (concentrated plating waste, cyanide rinsewater waste, and plating rinsewater) and liquid low-level | Rinsewater sludge to West Tank Farm and liquid effluent to mixed waste storage (West Tank 9616-8) | 9,900 $yd^3/yr$[b] (2,000,000 GPY) | Final NPDES, May 1, 1990. Permit only mows 28,000 gallons in three days. Total includes 4,970 $yd^3$ of mixed waste treatment. Also included in mixed waste treatment table. |
| Cyanide Treatment Unit (Bldg. 9201-5N) | Oxidation | Cyanide spent plating batches | Plating Solution to West End Treatment Facility | 33 (6,600 GPY) | Interim RCRA status September 19, 1992. Also has 11 $yd^3$ of mixed waste storage. Included in mixed waste treatment table. |
| Plating Rinsewater Treatment Facility (Bldg. 9409-11 and 9623) | Adsorption, clarification, neutralization, and reduction | Liquid hazardous (plating rinsewater) | Precipitated solid sludge to K-25 | 40,000 (8,000,000 GPY) | Final NPDES and RCRA permit January 1, 1990. Also included in mixed waste treatment table. |

[a] These are design capacities.

[b] Normal capacity ranges from 1,350,000 to 2,000,000 GPY.

Source: DOE 1993h; DOE 1994k; DOE 1994n; OR DOE 1994a.

TABLE H.2.3–5.—*Hazardous Waste Storage Capability at Y-12*

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Building 9404-7 PCB Drum Storage Facility | Solid PCB-contaminated materials only | 52 (13,700 gal) | Material may be contaminated with uranium. |
| Building 9418-9 | PCB-contaminated mineral oil | 70 (14,000 gal) | Below-grade, diked tank |
| Building 9720-9 Storage Area | Liquid and solid hazardous wastes to include PCBs | 1,290 (260,000 gal) | RCRA permit submitted September 24, 1991 and TSCA permit approved September 24, 1991. Part of building included in mixed waste storage table. |
| Contaminated Soils Storage Area | Solid RCRA hazardous wastes | 9,010 | RCRA permit submitted January 31, 1990. Standby mode. |
| Disposal Area Remedial Actions Liquid Storage Facility (Bldg. 9416-35) | Liquid hazardous wastes | 792 bulk (160,000 gal) | Interim status November 1, 1988. Also a treatment unit. Provides temporary storage prior to treatment. Includes two 75,000-gal bulk storage tanks and a 6,000-gal oil storage tank |
| Liquid Organic Waste Storage (Bldg. 9720-45, OD-10) | Liquid and solid hazardous ignitable nonreactive waste. Can also include mixed waste | 52 (10,600 gal)[b] | RCRA permit submitted December 1, 1991. A diked and covered storage area for 120 drums of material (80-gal drum) |
| Oil Landfarm Soils Storage Facility | Solid hazardous waste contaminated with PCBs and volatile organics (excavated soil from the closure of the Oil Landfarm) | 550 (111,000 gal) | Final RCRA permit June 30, 1989. No new wastes are being stored |
| RCRA Staging/Area | Liquid and solid hazardous waste to include PCB-contaminated waste | 221 (44,600 gal) | RCRA permit submitted January 31, 1990 |
| Waste Oil/Solvent Storage Facility III (Bldg. 9811-6) | Liquid hazardous waste including PCBs | 200 (40,000 gal) | RCRA permit submitted January 31, 1990. No radioactive contaminated waste, reactives, or ignitables |
| Waste Oil/Solvent Storage Facility IV (Bldg. 9811-6) | Liquid hazardous waste | 200 (40,000 gal) | RCRA permit submitted January 31, 1990. No radioactive waste, PCB waste, reactives, or corrosives |

[a] These are design capacities.

[b] Also included in mixed waste storage facility table.

Source: DOE 1994n; OR DOE 1993a; OR DOE 1994a; OR MMES 1993f.

**TABLE H.2.3–6.—*Inventory of Reactor-Irradiated Nuclear Material at Oak Ridge Reservation***

| Site | Facility | Type | Number and Form | Estimated Heavy Metal[a] ($yd^3$) |
|---|---|---|---|---|
| Oak Ridge National Laboratory | Building 3019 | SRS production fuel | 176 cans | .006 |
| | Building 3019 | Hanford production fuel | 42 cans | .006 |
| | Building 3019 | Commercial fuel (Canada ConEd) | 401 cans | .08 |
| | Building 4501 | Commercial fuel | 40 sections | .0005 |
| | Buildings 3525 and 7920, Dry Wells 7823A, 7827, and 7829 | Research reactor fuel | Fuel samples and targets | .007 |
| | Bulk Shielding Reactor | Research reactor fuel | 41 BSR elements and 32 ORR elements (pool 80% full) | .004 |
| | Classified Burial Ground | Unknown | Unknown | Unknown |
| | High Flux Isotope Reactor | Research reactor fuel | 43 Assemblies (pool 40% full) | .04 |
| | Homogeneous Reactor Experiment Wells | Research reactor fuel | 135 Gallons of uranyl sulphate[b] | .003 |
| | Molten Salt Reactor Experiment | Research reactor fuel | LiF and $BeF_2$ Salt Mixture | .003 |
| | Tower Shield Reactor | Research reactor fuel | 1 assembly (pool full) | .0007 |
| Y-12 Plant | Building 9720-5 | Space Nuclear Auxiliary Power-10 Fuel | 36 rods in NaK | .0004 |
| | Building 9720-5 | Health Physics Research Reactor Fuel | 31 HPRR fuel pieces | .01 |

[a] Based on conversion factor 13,700 kg/$yd^3$.
[b] Solution in seven holes with volume of 11 yd3.
Source: DOE 1993r; DOE 1994c; DOE 1994j.

**TABLE H.2.3–7.—*Mixed Transuranic Waste at Oak Ridge National Laboratory***

| Waste Matrix | Number of Waste Streams | Inventory as of December 31, 1992 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Multiple, alpha | 4 | 800 | 1 | 50 |
| **Remote-handled** | | | | |
| Multiple, alpha | 2 | 1,100 | 2 | 60 |
| **Total** | 6 | 1,900 | 3 | 110 |

Source: DOE 1994k; OR DOE 1994a.

TABLE H.2.3–8.—*Transuranic and Mixed Transuranic Waste Storage Capability at Oak Ridge National Laboratory*

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| TRU Retrievable Concrete Cask Storage Facility (Bldg. 7842) | Solid mixed TRU waste | 959 | Interim Part A permit (included in Part B application) |
| TRU Retrievable Concrete Cask Storage Facility (Bldg. 7855) | Solid mixed TRU waste | 181 | RCRA Part B submitted March 1992. May contain lead and mercury RCRA constituents |
| TRU Retrievable Drum Storage Facility (Bldg. 7826) | Contact-handled solid mixed TRU waste | 426 | RCRA permit submitted May 21, 1984. Mainly 55-gallon drums. May contain lead. Only contact-handled TRU, less than 200 mrem/hr. RCRA closure underway |
| TRU Retrievable Drum Storage Facility (Bldg. 7834) | Contact-handled solid mixed TRU waste | 533 | RCRA permit submitted January 14, 1993. Mainly 55-gallon drums. May contain lead. Only contact-handled TRU, less than 200 mrem/hr. RCRA closure underway |
| TRU Retrievable Drum Storage Facility (Bldg. 7802N Trenches) | Contact-handled solid mixed TRU waste | 937 | Under CERCLA closure |
| TRU Retrievable Concrete Cask Storage Facility (Bldg. 7878) | Contact-handled solid mixed TRU waste | 959 | Interim Part A permit (included in Part B application) |
| TRU Retrievable Drum Storage Facility (Bldg. 7879) | Contact-handled solid mixed TRU waste | 400 | Interim RCRA Part A permit (included on RCRA Part B application) |

[a] These are design capacities.

Source: DOE 1994k; DOE 1994n; OR DOE 1994a.

**TABLE H.2.3–9.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Oak Ridge National Laboratory***

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity ($yd^3$ per year) | Comment |
|---|---|---|---|---|---|
| Compactor (Bldg. 7831) | Compaction | Compactible solid LLW | Compacted solid LLW in B-25 (4x4x6 ft) boxes to K-25 | 14,800 | Design capacity |
| Liquid Low-Level Waste Evaporation Facility | Evaporation and ion exchange | Liquid LLW and mixed LLW | Evaporator condensates to Process Waste Treatment Plant. Some evaporator bottoms are stored at Melton Valley Facility. | 540 (109,360 GPY) | Normal operating capacity. Maximum capacity is 1,200 gal/hr for 20 hours per month. |
| Melton Valley Low-Level Waste Immobilization Facility | Decantation and stabilization | Remote-handled, alpha liquid mixed LLW | Solid LLW concrete block to storage | 248 (49,900 GPY) | Design capacity of 16,500 gal/mo |
| Nonradiological Wastewater Treatment Plant (Bldg. 3608) | Clarification, dual media pressure filter, air stripper carbon adsorption, neutralization filter press dewatering, ion exchange | Liquid and mixed LLW | Dewatered waste, carbon liquid discharge | 977,000 (197,100,000 GPY) | Normal generating capacity. Design capacity is 760 gpm |
| Process Waste Treatment Plant (Bldg. 3544) | Ion exchange, neutralization, clarification, and filter presses | Liquid LLW and mixed LLW | Solid LLW (filter cake) to storage at K-25. Wastewater is sent to nonradiological Wastewater Treatment Plant. | 347,000 (70,000,000 GPY) | Normal operating capacity. Design feedrate is 200 gpm for 24 hours each day per year. |
| Waste Handling and Packaging Plant | Evaporation, microwave solidification, solid segregation and packaging | Solid mixed LLW | | Planned | Remote handling capability for packaging |

Source: DOE 1993h; DOE 1994k; DOE 1994n; OR DOE 1993a.

**TABLE H.2.3–10.—*Low-Level and Mixed Low-Level Waste Storage Capability at Oak Ridge National Laboratory***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Eight Melton Valley Storage Tanks W-24 thru W-31 (248 $yd^3$ each) - Bldg. 783C | Solid mixed TRU (sludge) and LLW | 1,980 | RCRA permit submitted January 17, 1982. Solidified waste from LLW Evaporation Facility. |
| Building 7823B, 7823F, 7827, 7831C, 7842A, 7856, 7878A, B7823C, B7823D | Mixed LLW | 2,730 | No permit necessary |
| Buildings 7075, 7830A, 7934 | Mixed waste | 156 | Interim RCRA Part A (included in RCRA Part B application) |
| Bulk Contaminated Soil Facility (Bldg. 7576) | Low-level contaminated soil | 1,230 | Planned and funded. |
| Class III/IV Waste Storage | Class III and IV solid LLW | 741 | Planned and funded. RCRA Part B permit submitted March 30, 1992. |
| Facility 7841 | LLW (contaminated scrap metal) | 580 | No permit necessary |
| Five Evaporator Service Tanks - C-1 and C-2, W-21, W-23 (248 $yd^3$ each) | Solid mixed LLW | 1,240 | Final RCRA permit submitted January 17, 1992. |
| LLW Collection Tanks | Solid mixed LLW (sludge) | Various design capacities | Final RCRA permit submitted January 17, 1992. |
| Mixed Waste Drum Storage Pad (Bldg. 7507W) | Solid and liquid mixed LLW | 110 (22,200 gal) | Interim RCRA status May 1, 1984. TSCA permit submitted April 4, 1990. No reactive and explosive wastes. No waste with PCB greater than 2 ppm and radiation level greater than 10 mrem. PCB-contaminated and/or hazardous wastes are temporarily stored |
| SWSA-6 Staging Facility (Bldg. B7878) | Solid LLW and mixed waste | 196 | RCRA interim permit submitted January 14, 1993. |
| Staging Facility-Semi Underground (Bldg. 7823) | Mixed waste oils, solvents, and other process wastes | 144 (29,100 gal) | RCRA interim permit submitted January 14, 1993. |

[a] These are design capacities.

Source: DOE 1994n; OR DOE 1994a.

**TABLE H.2.3–11.—*Low-Level Waste Disposal Units at Oak Ridge National Laboratory***

| Disposal Unit | Input Capability | Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Asbestos Silos (SWSA-6) | Low-level contaminated asbestos | 614 | Unit accepts only Y-12 asbestos, if contaminated with other than uranium contamination, other than that no offsite waste accepted |
| Biological Trenches (SWSA-6) | Low-level contaminated biological waste | 3,310 | Landfill operation |
| Fissile Well (SWSA-6) | Low-level fissile isotope (U-235, U-233, and TRU isotopes < 100 nCi/g) waste | 380 | Fissile wells are 30-inch diameter cast iron pipe encased in concrete |
| High Range Silos (SWSA-6) | Solid LLW (200 mrem/hr to 1 rem/hr) | 2,740 | Concrete silos inside diameter (15 ft x 8 ft) |
| High Range Wells (SWSA-6) | Remote-handled solid LLW (1 rem/hr) | 1,560 | High range wells are 30-inch diameter cast iron pipe encased in concrete |
| Interim Waste Management Facility | Solid LLW B-25 boxes encased in concrete | 7,050 | Planned - 6 Tumulus facilities (60 ft x 90 ft) |
| Low Range Silos (SWSA-6) | Solid LLW (<200 mrem/hr) | 5,030 | Concrete silos inside diameter (15 ft x 8 ft) |
| Solid Waste Storage Area 6 (SWSA-6), Bldg. 7822 | Solid LLW | 1,080,000,000[b] | No mixed waste currently received. Only sludges with no free liquids. RCRA interim status - April 1, 1986 |
| Tumulus Pad II (SWSA-6) | Noncompactible contact handled (<200 mrem/hr) solid LLW in B-25 boxes encased in concrete | 780 | Pad is 60 ft x 90 ft. Non-operational due to pending closure. |

[a] These are design capacities.

[b] Individual areas in SWSA-b also included in table.

Source: DOE 1994n; OR MMES 1993d.

**TABLE H.2.3–12.—*Mixed Low-Level Waste at Oak Ridge National Laboratory***

| Waste Matrix | Number of Waste Streams | Inventory as of December 31, 1992 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Aqueous liquid | 7 | 70 (14,100 gal) | 6 | 130 (26,000 gal) |
| Organic liquids | 9 | 150 (30,200 gal) | 6 | 130 (26,700 gal) |
| Inorganic liquids | 8 | 100 | 4 | 70 |
| Solids | 1 | 5 | None | None |
| Debris | 6 | 4 | 2 | 0.3 |
| Lab packs | 5 | 90 | 5 | 15 |
| Elemental mercury | 1 | 2 (320 gal) | 1 | 0.2 (30 gal) |
| Batteries | 1 | 2 | 1 | 1 |
| Others | 1 | 80 | 1 | 50 |
| **Remote-handled** | | | | |
| Aqueous liquid, alpha | 2 | 3,040 (613,000 gal) | 1 | 80 (15,300 gal) |
| **Total** | 41 | 3,543 | 27 | 477 |

Source: DOE 1994k; OR DOE 1994a.

**TABLE H.2.3–13.—*Hazardous Waste Treatment Capability at Oak Ridge National Laboratory***

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity[a] | Comment |
|---|---|---|---|---|---|
| Chemical Detonation Facility (Bldg. 7667) | Open burning | Solid and liquid explosive wastes (lab pack flammables) | Residue (ash) to Sludge Fixation Facility for treatment | Campaign | RCRA interim permit submitted January 14, 1993. |
| Neutralization Facility (Bldg. 3518) | Neutralization | Liquid acids | Liquid effluent through NPDES and storage to Nonradiation Waste Treatment Plant | 58,800 $yd^3$/yr | Final RCRA permit submitted January 17, 1992. Design feedrate is 30 $yd^3$/yr. |

[a] For those facilities already in use, this is a normal operating capacity; for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1994n.

**TABLE H.2.3–14.—*Hazardous Waste Storage Capability at Oak Ridge National Laboratory***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Chemical Waste Storage Facility (Bldg. 7653) | Solid explosives, lab pack chemicals, and waste reactive metals | 33 (6,720 gal) | RCRA interim permit application submitted January 14, 1993. |
| Clean Oil Storage Pad (Bldg. 7651) | Clean oil | 37 (7,470 gal) | RCRA interim permit submitted January 14, 1993. Can be used for mixed wastes. |
| Hazardous Waste (PCB) Storage Facility (Bldg. 7507) | Liquid PCB | 41 (8,220 gal) | RCRA interim permit submitted January 14, 1993. Can be used for mixed waste. |
| Hazardous Waste Storage Facility (Bldg. 7652) | Hazardous bulk liquids and solids | 74 (14,900 gal) | Final RCRA Part B September 1, 1986. Can be used for mixed wastes. |
| Long-term Hazardous Waste Storage Facility (Bldg. 7654) | Liquid solid hazardous wastes | 81 (16,400 gal) | RCRA interim permit submitted January 14, 1993. Can be used for mixed wastes. |

[a] These capacities are design capacities.

Source: DOE 1994n; OR DOE 1993a.

**TABLE H.2.3–15.—*Low Level, Mixed Low-Level and Hazardous Waste Storage Capability at K-25 Site* [Page 1 of 4]**

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Dewatered Raw Sludge Storage (Bldg. K-1065C) | Mixed LLW | 19,700 | RCRA permit expires 2023. |
| Dewatered Raw Sludge Storage (Bldg. K-31) | Mixed LLW | 10,500 | RCRA permit expires 2002. |
| Flammable Liquid Storage Tanks (K-1202) | Liquid LLW, mixed LLW, and hazardous waste | 140 (28,500 gal) | RCRA permit expires September 1, 2002. No reactive or PCB waste. Flammable or nonflammable RCRA regulated liquids that are radioactively contaminated. |
| Flammable Liquid Storage Unit (K-1420A) | Liquid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs | 140 (28,500 gal) | RCRA permit expires September 1, 2002. No reactive or incompatible waste. Waste includes flammable solvents, gasoline, and paint waste. |
| Hazardous Waste Storage Unit, WSU-002 (K-311-1) | Solid LLW, mixed LLW, hazardous, and non-RCRA waste | 596 | RCRA permit expires September 1, 2002. No ignitable, reactive or incompatible waste. Waste includes lead ingots, lead slag, and lead carbonate contaminated with low-level radioactive contaminants. |
| Hazardous Waste Storage Unit, WSU-005 (K-310-1) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste | 580 (117,000 gal) | RCRA permit expires September 1, 2002. No ignitable or reactive waste. RCRA sludges and ash from operation of K-1035 incinerator. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-006 (Vault 2A) | Mixed LLW | 576 | RCRA permit expires September 1, 2002. |
| Hazardous Waste Storage Unit, WSU-066 (Vault 2A) | Mixed LLW | 576 | RCRA permit expires September 1, 2002. |

**TABLE H.2.3–15.—*Low Level, Mixed Low-Level and Hazardous Waste Storage Capability at K-25 Site* [Page 2 of 4]**

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Hazardous Waste Storage Unit, WSU-007 (K-309-3) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste | 463 (93,400 gal) | RCRA permit expires September 1, 2002. No ignitable or reactive waste. Has been used for RCRA, PCB, and mixed wastes from all sites at ORR. |
| Hazardous Waste Storage Unit, Vault 4, WSU-011 (K-301-1) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 563 (114,000 gal) | RCRA permit expires September 1, 2002. No waste with flash point < 100 °F. Storage of PCB acids and PCB organics. |
| Hazardous Waste Storage Unit, WSU-012 (K-301-1, Vault 4A) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 833 (168,000 gal) | RCRA permit expires September 1, 2002. No waste with flash point < 100 °F. Waste consists of sludges and incinerator ash. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-013 (K-301-2, Vault 4B) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 496 (100,000 gal) | RCRA permit expires September 1, 2002. No waste with flash point < 100 °F. Waste consists primarily of photographic waste and incinerator ash. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-023 (K-302-4) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 500 (101,000 gal) | RCRA permit expires September 1, 2002 No reactives or ignitables. No waste with flash point < 100 °F. Storage of PCB organics and mercury contaminated organics. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-024 (Vault 8A) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 710 (143,000 gal) | RCRA permit expires September 1, 2002. No reactives or ignitables. No waste with flash point < 100 °F. Storage of hazardous wastes from K-25 and Y-12. |
| Hazardous Waste Storage Unit, WSU-025 (K-302-5) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 500 (101,000 gal) | RCRA permit expires September 1, 2002. No reactives or ignitables. No waste with flash point < 100 °F. Storage of RCRA and mixed wastes from K-25 and Y-12. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-026 (K-303-1) | Liquid and solid mixed LLW | 724 (156,000 gal) | RCRA permit expires September 1, 2002. |
| Hazardous Waste Storage Unit, WSU-028 (K-303-2) | Liquid and solid mixed LLW | 648 (131,000 gal) | RCRA permit expires September 1, 2002. |
| Buildings K-1232, K301-4, K303-1, K-303-2, K303-3, K-305-12, K306-4 | Mixed waste | 3,600 (726,000 gal) | Permitted. |
| Building K-306-IT | LLW and hazardous waste | 204 (41,100 gal) | Permit not necessary. |
| Buildings K-1417 and K-1419 | Mixed waste | 11,600 | Under RCRA closure. |
| Hazardous Waste Storage Unit, WSU-056 (Vault 19A) | Liquid and solid mixed LLW | 774 (156,000 gal) | RCRA permit expires September 1, 2002. |
| Hazardous Waste Storage Unit, WSU-057 (K-305-6) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 463 (93,400 gal) | RCRA permit expires September 1, 2002. No waste with flash point < 100 °F. Part of former K-305-6 vaults 19 and 19B. Storage of K-25 pond waste sludge from closure of K-1407B pond. |
| Hazardous Waste Storage Unit, WSU-066 (K-305-12) | Liquid and solid mixed LLW | 474 (95,600 gal) | RCRA permit expires September 1, 2002. |

TABLE H.2.3–15.—*Low Level, Mixed Low-Level and Hazardous Waste Storage Capability at K-25 Site* [Page 3 of 4]

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Hazardous Waste Storage Unit, WSU-067 (K-306-1) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 130 (26,000 gal) | RCRA permit expires September 1, 2002. No reactives or ignitables. No waste with flash point < 100 °F. Sludges generated during treatment of Y-12 wastewaters. |
| Hazardous Waste Storage Unit, WSU-068 (Vault 23A) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 426 (85,900 gal) | RCRA permit expires September 1, 2002. No reactives or ignitables. No waste with flash point < 100 °F. Sludges generated during treatment of Y-12 wastewaters at either K-1232 or Y-12 facilities. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-070 (K-306-3) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 374 (75,400 gal) | RCRA permit expires September 1, 2002. No reactives or ignitables. No waste with flash point < 100 °F. Storage of RCRA, PCB, and mixed wastes from K-25, Y-12, and ORNL. |
| Hazardous Waste Storage Unit, WSU-072 (K-306-4) | Liquid and solid mixed LLW | 374 (75,400 gal) | RCRA permit expires September 1, 2002. |
| Hazardous Waste Storage Unit, WSU-074 (Vault 25A) | Liquid and solid mixed LLW | 374 (75,400 gal) | RCRA permit expires September 1, 2002. |
| Hazardous Waste Storage Unit, WSU-1000 (K-1036-A) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 174 (35,100 gal) | RCRA permit expires September 1, 2002. Wastes must be compatible. Used for solvents and waste oil storage. Oil may be contaminated. Max. capacity 2,000 55-gal drums. |
| Hazardous Waste Storage Unit, WSU-1003 (K-711) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs | 303 (61,300 gal) | RCRA permit expires September 1, 2002. No reactives or incompatibles. Waste oils and solvents generated at Fernald, Ohio and other DOE facilities. Max. capacity of 1,800 55-gal drums. |
| Hazardous Waste Storage Unit, WSU-1004 (K-1025C) | Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA wastes | 7 (1,490 gal) | RCRA permit expires September 1, 2002. No incompatibles. Used for out-of-date or off-specification laboratory chemicals - disposed through offsite commercial facilities. No remaining capacity as of August 1994. |
| Hazardous Waste Storage Unit, WSU-1005 (K-1302) | LLW, mixed LLW, hazardous, and non-RCRA compressed gas | 4 (747 gal) | RCRA permit expires September 1, 2002. Gases are commercial products that are to be discarded or treated. No remaining capacity as of August 1994. |
| K-770 Clean Scrap Yard | Nonradioactive scrap metal | Variable | Scrap metal stockpiled before being sold to public. |
| RCRA Storage Unit (WSU-009), Vault 3A | Liquid and solid LLW and hazardous wastes | 381 (76,900) | Final permit September 1, 1992. Will be used for RCRA and mixed wastes from K-25, Y-12, and ORNL. Currently, empty PCB-contaminated containers from K-25 and Y-12 being stored in vault. |
| TSCA Container and Tank Storage (K-1435) | Non-PCB contaminated flammable liquid and mixed low-level that is also PCB-contaminated | 689 (139,000 gal) | TSCA incinerator has three storage areas. The tank farm has 3 10,000-gal and 12 5,000-gal tanks for liquid only. Area B (TSCA waste) can store 352 55-gal drums and Area C (RCRA waste) can store 496 55-gal drums. Final state air permit expires October 1, 1993 and state RCRA permit submitted August 1, 1991. |
| TSCA Storage Unit (K-33) | Liquid and solid hazardous waste | 1,260 (254,000 gal) | No permit required. |

**TABLE H.2.3–15.—*Low Level, Mixed Low-Level and Hazardous Waste Storage Capability at K-25 Site* [Page 4 of 4]**

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| TSCA Storage Unit (K-726) | Liquid and solid - LLW and non-RCRA, nonradioactive waste contaminated with PCBs | 110 (22,400 gal) | No waste with flash point < 100 °F Nonhazardous organic waste contaminated with PCB. |
| TSCA Storage Unit, WSU-031 (K-303-4) | Liquid and solid - LLW and non-RCRA, nonradioactive waste contaminated with PCBs | 2,320 (468,000 gal) | No waste with flash point < 100 °F. RCRA permit submitted October 1, 1991. Used for PCB-contaminated soil and absorbent (Zorball). |
| Waste Oil/Hazardous Wastes Storage I (K-1425 container) | Liquid and solid LLW and mixed LLW | 244 (49,000 gal) | RCRA state permit submitted March 1, 1991. Wastes stored include oils, solvents, water, and organics. Max. capacity 480 55-gal drums. |
| Waste Oil/Hazardous Wastes Storage II (K-1425 tanks) | Liquid LLW and mixed LLW | 450(90,000 gal) | Final air permit expires October 1, 1995 and RCRA state permit submitted August 1, 1991. Wastes stored include oils, solvents, water, and organics. Four 22,500-gal tanks. |
| Waste Staging Facility (K-1423) | Liquid and solid - non-RCRA, nonradioactive; hazardous; LLW; and mixed LLW | 371 (74,800 gal) | Planned and funded for April 1, 1999. |
| Vault 2A, 19A, 25A | Mixed waste | 1,350 | Permitted. |
| K 303-3/Vault 10A, 11A | Solid LLW and mixed LLW | 774 | Permitted. |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance. These capacities are the practical capacity rather than the design capacity.

Source: DOE 1994n; OR DOE 1993a, OR DOE 1994a; OR MMES 1993e; ORR 1993a:11.

**TABLE H.2.3–16.—*Low-Level, Mixed Low-Level, and Hazardous Waste Treatment Capability at K-25 Site* [Page 1 of 2]**

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity | Comment |
|---|---|---|---|---|---|
| Central Neutralization Facility (K-1407H) | Clarification, thickening, and neutralization | Liquid LLW, mixed LLW, and hazardous waste | Liquid effluent through NPDES outfall and sludge to Hazardous Waste Storage Unit | 189,000 $yd^3$/yr (38,000,000 GPY) | Final NPDES permit October 1, 1992. Permitted capacity is 58,400 GPY. |
| Combustible Mixed Waste Treatment Facility | Thermal destruction | Combustible debris, heterogeneous debris | Ash, Wastewater, Ash-flyash | 796 $yd^3$/yr | Planned and unapproved. Feasibility study estimated treatment capacity at 800 tons per year. |
| K-1420 Decon Facility | Decontamination and neutralization | Solid LLW and mixed LLW Metal debris, Inorganic non-metal debris | Decon solution to Sludge Fixation Facility, decreases sludge and inorganic sludge to storage and wastewater to Central Neutralization Facility | Campaign (currently on a case-by-case basis) | Configured for LLW only. Can be modified to handle mixed waste. Current use is for dry surface decontamination only. |

**TABLE H.2.3–16.—*Low-Level, Mixed Low-Level, and Hazardous Waste Treatment Capability at K-25 Site* [Page 2 of 2]**

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity | Comment |
|---|---|---|---|---|---|
| Sludge Fixation Facility (K-1417) | Encapsulation (solidification) | Fly ash, new sludge, holding pond sludge, mixed liquid and sludge | Fixed sludge, rinse water sent to Central Neutralization Facility, fixed drums to K-1017 Concrete Block Casting and Storage Yard for storage | 79 $yd^3$/day 16,000 gal/day | Standby mode including free liquids due to bad product and lack of LLW or mixed waste. |
| TSCA Incinerator (K-1435) | Incineration (rotary kiln) | Liquid and solid - mixed LLW, LLW and mixed LLW contaminated with PCBs | Ash (solid mixed LLW and hazardous) to Hazardous Waste Storage Unit, WSU-012, ash water and blowdown water (mixed LLW and hazardous) to Central Neutralization Facility, and sludge (solid mixed LLW) to Sludge Fixation Facility | 2,440 $yd^3$/yr (liquids) (491,000) | Final state air permit expires October 2, 1993; state RCRA permit expires September 27, 1997 and TSCA permit expires March 20, 1992. |
| Waste Incinerator (K-1421) | Incineration | Type "O" waste contaminated trash | Ash (solid LLW) to Hazardous Waste Storage Unit, WSU-013 | 0.1 $yd^3$/hr | The facility is non-operational due to upgrades. |
| Wastewater Treatment Facility (K-1232) | Centrifugation, neutralization, and precipitation | Liquid mixed LLW | Leachate (liquid LLW) to Central Neutralization Facility and sludge (solid mixed LLW) to Sludge Fixation Facility | 0.4 $yd^3$/hr | RCRA permit submitted May 18, 1989. |
| Metal and Debris Waste Treatment Facility | Surface decontamination | Metal debris inorganic non-metal debris, heterogeneous | Wastewater treated debris, sludges | Planned and unapproved | Plan to treat mixed waste |
| Mixed Sludge Treatment Infrastructure | Radioactivity concentration, stabilization precipitation, filtration, off-gas treatment sampling analysis | Wastewater, treatment sludges, ash, plating waste sludges | Stabilized sludges, stabilized solids-rad, wastewater | Planned and unapproved | Technologies and processes are still being determined. |
| Staging and Processing Facility | Repackaging/bulking/consolidation, rinsing PCB drum, pH adjustment | Aqueous/halogenated organic liquids, absorbed organic liquids, paint chip/solids, activated carbon, biological materials, organic chemicals, contaminated soils | Wastewaters, drums, organic rinsate | Planned and unapproved | |
| Waste Soils Treatment Facility | Thermal desorption (primary), possible soil watering | Contaminated soils | LDR soils, debris, scrubber residues | Planned and unapproved | |

Source: DOE 1994k; DOE 1994n; OR MMES 1993e.

**TABLE H.2.3–17.—*Low-Level Storage Capability at K-25 Site***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Building K-1066H, K-33, RUBB-2 | LLW | 178 (35,900 gal) | No permit necessary. |
| Contaminated Scrap Metal Yard (K-770) | Solid LLW (uranium-contaminated scrap metal, ferrous and nonferrous) | 38,800 | 6.9 acres of contaminated scrap metal. No remaining capacity as of August 1994. |
| LLW Storage Unit, WSU-003 (K-310-3) | LLW and non-RCRA, nonradioactive (soils and metals) | 1,530 (308,000 gal) | RCRA permit expires September 1, 2002. Construction upgrades required before storage of mixed waste. Used for nonhazardous radioactively contaminated waste generated at Y-12. |
| LLW Storage Unit, WSU-004 (K-310-2) | Liquid and solid LLW | 1,530 (308,000 gal) | Used for nonhazardous radioactively contaminated waste generated at ORNL. |
| LLW Storage Unit, WSU-008 (K-309-2) | Liquid and solid LLW, non-RCRA, and nonradioactive (soils and metals) | 867 (175,000 gal) | Used for nonhazardous radioactively contaminated waste from K-25. |
| LLW Storage Unit, WSU-032 (K-303-5) | Liquid and solid LLW, non-RCRA, and nonradioactive (soils and metals) | 616 (124,000 gal) | RCRA permit expires September 1, 2002. Construction upgrades required before storage of mixed waste. Used for nonhazardous radioactively contaminated waste from K-25. |
| LLW Storage Unit, WSU-044 (Vault 15A) | Liquid and solid LLW, non-RCRA, and nonradioactive (soils and metals) | 737 (149,000 gal) | RCRA interim status September 1, 1990. Construction upgrades required before storage of mixed waste. Used for nonhazardous radioactively contaminated waste from K-25. |
| LLW Storage Unit, WSU-047 (Vault 16A) | Liquid and solid LLW-fissile material | 4,670 | No permit necessary. |
| LLW Storage Unit, (K-1420 Mazzan) | Liquid and solid LLW-fissile material | Variable | No permit necessary. |
| LLW Storage Unit (Vault 31X) | Liquid and solid LLW | 3,270 (659,000 gal) | RCRA permit expires 2002. |
| LLW Storage Unit WSU-001 (Vault 1X) | Liquid and solid LLW fissile material | 16 (3,250 gal) | No permit necessary. |
| LLW Storage Unit (K-306-2) | Liquid and solid LLW, non-RCRA, and nonradioactive (soils and metals) | 248 (50,000 gal) | Used for nonhazardous radioactively contaminated soil from Y-12. |
| LLW Storage Unit, WSU-076 (K-306-7) | Liquid and solid LLW, non-RCRA, and nonradioactive (soils and metals) | 410 (82,900 gal) | Used for nonhazardous radioactively contaminated soil from Y-12. |
| LLW Storage Unit, (K 1066-4) | Solid LLW | 5,010 | No permit necessary. |
| Vault 6 | LLW | 222 | No permit necessary. |
| K-33 WP | LLW | 11,100 | No available capacity as of August 1994. |
| K-33 LLW Drum (new) | LLW | 1,260 | No permit necessary. |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: DOE 1994n; OR DOE 1993a;OR DOE 1994a; OR MMES 1993e.

TABLE H.2.3–18.—*Mixed Low-Level Waste at K-25 Site*

| Waste Matrix | Number of Waste Streams | Inventory as of December 31, 1992 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Aqueous liquids | 15 | 360 (72,300 gal) | 4 | 200 (39,800 gal) |
| Organic liquids | 27 | 1,300 (263,000 gal) | 9 | 6,200 (1,250,000 gal) |
| Inorganic residues | 8 | 12,400 | 6 | 1,100 |
| Organic residues | 22 | 680 | None | None |
| Uncategorized soils | 1 | 5 | 1 | 12 |
| Metal and inorganic debris | 15 | 240 | 10 | 580 |
| Labpacks | 12 | 4 | 10 | 10 |
| Compressed gases | 5 | 3 (650 gal) | 1 | 14 (2,900 gal) |
| Elemental mercury | 3 | 220 | 1 | 1 |
| Elemental lead | 1 | 28 | 1 | 1 |
| Batteries | 2 | 8 | 1 | 58 |
| Uncategorized | 4 | 17 | None | None |
| Cement forms | 1 | 20,600 | None | None |
| **Total** | 116 | 35,900 | 44 | 8,200 |

Source: DOE 1994k; OR DOE 1994a.

### H.2.4 Pantex Plant

This section describes the baseline conditions and specific waste management operations at the Pantex Plant (Pantex). As part of its normal operations, Pantex generates low-level, mixed low-level, hazardous, and nonhazardous wastes. Tables H.2.4–1 and H.2.4–2 present a detailed description of treatment and storage facilities with estimated capacities.

Pantex's goals regarding the management of LLW, mixed LLW, and hazardous wastes are to:

- Minimize the volumes of low-level radioactive and hazardous wastes generated to the extent technologically and economically practicable.
- Recycle those wastes applicable to the best available technology.
- Minimize contamination of existing or proposed real property and facilities.
- Ensure safe and efficient long-term management of all wastes.

**Pollution Prevention.** Pantex has a waste minimization program that was formed to define an effective waste minimization system for the site. A committee provides awareness of the program, identifies tasks, and provides liaison between the site and outside entities. Some of the accomplishments of this program are as follows (PX MH 1991a:8-11):

- Compactor used to compact 1,200 drums to approximately 250 drums. Disposal cost savings of approximately $300,000 was achieved.
- Separate radioactive and hazardous waste materials when shearing weapons components. Reclamation of gold from this process netted $243,000.
- Reclamation of oil, antifreeze, and refrigerant.
- Substitution of scintillation solution that is nonhazardous.
- Reuse of explosives and solvents.
- Repackaging of paint into smaller containers.
- Substitution of naphtha with nonhazardous biodegradable cleaning solution.

**Low-Level Waste.** The waste streams for LLW have the following options available for management consideration (PX MH 1990b:13):

- Continue to ship to an approved DOE disposal site such as NTS.
- Compact solid waste, if possible.
- Computerize tracking of radioactive waste.
- Implement improved segregation program.

Solid LLW generated consists of contaminated parts from weapons assembly and disassembly functions and waste materials associated with these functions, such as protective clothing, cleaning materials, filters, and other similar materials. The compactible components of this waste are processed at the Pantex Solid Waste Compaction Facility and staged along with the noncompactible components for shipment to a DOE-approved disposal site. Table H.2.4–3 lists Pantex's primary LLW streams, how they are generated, primary radioactive constituents, and method of storage or disposal.

**Mixed Low-Level Waste.** The waste streams for mixed LLW have the following options available for management consideration:

- Treat to satisfy Land Disposal Restrictions requirements and ship to an approved DOE facility for storage or disposal.
- Treat to satisfy Land Disposal Restriction requirements and ship to an approved commercial facility for storage or disposal.
- Ship offsite for treatment and disposal.

Pantex generates solid mixed LLW during weapons component testing functions. These wastes consist primarily of depleted uranium and beryllium residue and fragments from explosive components tests, contaminated gravel, cleaning materials, and protective clothing associated with these operations (PX MH 1990b:35). Other mixed LLW streams include cleaning materials from weapons assembly and disassembly operations. Table H.2.4–4 lists Pantex's primary mixed waste streams, how they are generated, primary constituents, materials, and method of treatment. Table H.2.4–5 lists the mixed waste storage inventory as of April 15, 1994. Projections for the following five years are also included.

The FS-23 facility has a containment test fire chamber where oxides of depleted uranium and beryllium are generated from testing. The chamber and equipment are cleaned after each test and the residue (solid waste) is placed into shipping containers. The containers are monitored for contamination and then forwarded to a staging area for shipment offsite.

Mixed LLW (HE-contaminates only) is currently treated at the Burning Ground which has an operating capacity of 48 $yd^3$ per year (DOE 1994k). The Hazardous Waste Treatment and Processing Facility is being planned to treat mixed LLW in the future.

**Hazardous Waste.** The waste streams for hazardous waste have the following options available for management consideration:

- Continue to ship to approved hazardous waste disposal facilities
- Encapsulate solid waste and ship to an approved DOE disposal site.
- Treat onsite for neutralization of corrosive wastes.

Table H.2.4–6 lists Pantex's primary hazardous waste streams, how they are generated, primary constituents, and method of storage or disposal.

The treatment of hazardous waste is done at the following facilities:

- The Burning Ground is an open-burning area where explosives, explosive-contaminated waste, and explosive-contaminated spent solvents are burned. A large volume reduction is attained by this treatment.
- The machine shop is permitted for treatment of electroplating effluents but is currently not in use.

There are several separate storage facilities for hazardous wastes.

- Hazardous Waste Drum Storage Area—All liquid drums are placed in spill-containment pans. The facility is inspected weekly for leakers. Small lab samples of hazardous waste are stored in two chemical storage containers in this area. The materials stored there are as follows:
  - Asbestos;
  - Mercury-contaminated wastes;
  - Burning Ground ash; and
  - Electroplating sludge.
- At Building 16-1, used crank case oil is stored underground until sufficient quantities are generated for offsite processing.

**Nonhazardous Waste.** The Sewage Community Treatment Quality Upgrade is a fiscal year 1996 EM project at Pantex. This project would upgrade the Pantex sanitary system to ensure that wastewater standards are met through secondary/tertiary treatment. Included in this project is the upgrade of the existing treatment lagoon to treat sewage, repair and replace existing deteriorated sewer lines, construct a closed system to eliminate the use of open ditches for conveyance of industrial wastewater discharges, and implement a plant stormwater management system.

**TABLE H.2.4–1.—*Waste Treatment Capability at Pantex Plant***

| Treatment Unit | Treatment Method(s) | Input Capability | Output Capability | Total Capacity[a] | Comment |
|---|---|---|---|---|---|
| Batch Master Hazardous Waste Tank System (Bldg. 12-68) | Filtration, neutralization, and precipitation | Bldg. 12-5C metal cleaning bath, plating process waste, sodium hydroxide radiator cleaner, and spent electrolyte solutions | Batch Master Metal precipitates to Hazardous Waste Storage Pad and effluent to Wastewater Treatment Plant | Process as needed | Non operational due to pending closure |
| Building 11-15A | Immobilization | Mixed LLW | To be determined | 240 $yd^3$/yr | Planned |
| Building 11-9 | Immobilization | Mixed LLW | To be determined | 240 $yd^3$/yr | Planned |
| Burning Cages (2) | Open burning | HE-contaminated trash | Ash | 164 $yd^3$/batch | Interim permit until December 31, 1999. Non operational due to upgrades/major repairs |
| Burning Pads (3) -Burning Ground | Open burning | HE and wet HE | Ash to 11-7N Storage Pad | Process as needed | Interim permit until December 31, 1999 |
| Burning Trays (9) -Burning Ground | Open burning | Bulk explosives | Ash to 11-7N Storage Pad | 0.7 $yd^3$/batch | No two adjacent trays are allowed to burn at the same time. |
| Closed-Loop Decon System | Reduction | Contaminated lead (solid mixed LLW) | Acid Bath (liquid mixed LLW) to NSSI | Campaign | One process per year. Standby mode. |
| Compactor (Bldg. 12-42) | Hydraulic ram compactor - in-drum compaction | Solid LLW (gloves, kim wipes, paper) | Compacted LLW in 17H 55-gallon drums to Storage Igloo 4-56 | Process as needed | No TRU waste, Greater than Class C, mixed waste, free liquids, or gases |
| Flashing Pits (3) -Burning Ground | Open burning | Encased explosives, demilitarization, and sanitization, HE-contaminated equipment, and HE | Flashed scrap to sale as scrap | Process as needed | Interim permit until December 31, 1999 |
| Hazardous Waste Treatment & Processing Facility | Immobilization repackaging, neutralization compaction, shredding, sorting, and solidification | Liquid and solid mixed LLW and hazardous waste | To be determined | 655 $yd^3$/yr | Available for treating mixed waste by 1999 |

[a] For those facilities already in use this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability funds and permit issuance.

Source: DOE 1993h; DOE 1994n; PX MMES 1993a.

**TABLE H.2.4–2.—*Waste Storage Capability at Pantex Plant***

| Storage Unit | Input Capability | Total Capacity ($yd^3$)[a] | Comment |
|---|---|---|---|
| Classified Hazardous Waste Staging Facility (Bldg. 16-16) | Containerized liquid and solid mixed low-level and hazardous wastes | 545 (110,000 gal) | Available November 1, 1995 |
| Conex Containers WM-1 to WM-8 | Containerized solid mixed low-level and silver photo wastes | 1,730 | Permit dated April 1, 1991 |
| Conex Container WM-1A, WM-1B, WM-3A, WM-5A, WM-5B, WM-37, WM-42, and PACD 1-10 | Containerized liquid and solid LLW | 157 (32,000 gal) | Capacity estimate made based on 72 drums per conex (55 gal drums). No plans to receive offsite waste |
| Hazardous Waste Staging Facility (Bldg. 16-17) | Containerized liquid and solid mixed LLW | 545 (110,000 gal) | Available November 1, 1995. Planned and funded. |
| Hazardous Waste Storage Pad (Bldg. 11-7N) | Various liquid and solid hazardous wastes | 164 (33,000 gal) | Interim permit dated April 19, 1990 |
| Hazardous Waste Storage Pad (Bldg. 11-9N) | Various liquid and solid hazardous wastes | 500 (100,000 gal) | Permit dated March 1994 |
| Igloo 4-50 | Hazardous wastes only | 550 | Final permit dated April 24, 1992 |
| Igloo 4-56 | Liquid and solid LLW | 56 (11,000 gal) | No plans to receive offsite waste |
| Warehouse (Bldg. 12-42) | Solid LLW | 22,000 | Short-term storage for drums that go to Bldg. 4-56 |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: DOE 1994n.

**TABLE H.2.4–3.—*Low-Level Waste Streams at Pantex Plant***

| Process | Generation | Constituents | Materials | Disposal/Storage Method |
|---|---|---|---|---|
| Weapons components, retirement | Discarded components from weapons assembly, disassembly operations. | U-238 (may contain trace alpha contamination and/or tritium) | Generally noncompactible discarded weapons components. | Staged for shipment |
| Weapons components, health physics | Waste materials from normal health physics operations associated with weapons assembly/disassembly, facility surveillance, container monitoring and routine sample counting operations. | U-238, tritium, thorium, and plutonium | Protective clothing, wipes, swipes, tape, plastic and other LLW generated in the radiation protection program. | Staged for shipment |
| Stored waste | Waste generated during explosive test of mock devices at a remote outside testing area, various stored waste not associated with any known waste stream. | Depleted U-238 residue | Contaminated soil and gravel, additional unidentified materials. | Stored at contaminated test site, eventual shipment to DOE-approved disposal site. |
| Decontamination products | Materials generated during the decontamination of a concrete assembly work cell. | Tritium | Protective clothing, concrete rubble, solidified liquids, tools, equipment, plastic and paper products containing tritium. | Currently at contaminated test site, eventual shipment to DOE-approved disposal site. |

Source: PX MH 1988a; PX MH 1990b.

**TABLE H.2.4–4.—*Mixed Low-Level Waste Streams at Pantex Plant* [Page 1 of 2]**

| Treatability Group | Waste Stream Name | Composition[a] | Process Description | Treatment Alternatives |
|---|---|---|---|---|
| Organic liquids | Paint waste, spent solvents, mercury-contaminated liquid, miscellaneous organic liquids, scintillation vials | Paint and solvent, freon, MEK, HE, DMSO, mercury-contaminated oil, account material, scintillation vials | Paint residual and solvents, spent solvents, discarded oil, off-spec product, scintillation | Encapsulation, incineration, molten salt destruction, filtration, centrifugation, oxidation reduction, and amalgamation (mercury only) |
| Aqueous liquids | wastewater, alodine solution, rinsewater, metal cleaning waste | Water, HE, chromium, lead, alodine with water HE, lead, water, alodine, nitric acid, U, Th, and Hg | HE contaminated wastewater, cleaning solution, rinse water, metal cleaning waste | Incineration and wastewater treatment |
| Organic solids | Not available | Not available | Not available | Plasma melting, chemical leaching, and encapsulation |
| Inorganic solids | Lead waste | Lead | Lead scrap | Plasma melting, chemical leaching, and encapsulation |
| Soils | ER Program potential mixed waste (soils) | Not available | ER Program site contaminated soils; drill cuttings; sample waste | Encapsulation, thermal, physical, chemical, and containment |
| Debris | Organic debris: solvent-contaminated solids | Alcohol, kimwipes, filters, rags, leads, solvents | Debris waste | Encapsulation, incineration, and metal melting |
| | Inorganic debris: contaminated scrap metal | Contaminated scrap metal | Demilitarized and sanitized weapons parts | Slagging, plasma melting, molten salt, aqueous washing, chemical leaching, sonification, and amalgamation (mercury only) |

**TABLE H.2.4–4.—*Mixed Low-Level Waste Streams at Pantex Plant* [Page 2 of 2]**

| Treatability Group | Waste Stream Name | Composition[a] | Process Description | Treatment Alternatives |
|---|---|---|---|---|
| | Inorganic debris: lead-contaminated waste | Lead waste | Demilitarized and sanitized weapons parts | |
| | Inorganic debris: mercury-contaminated solids | Glass Bulbs, mercury-contaminated solids | Mercury solid waste | |
| | Heterogeneous debris | Metals, solvents, lead, tritium, beryllium | Heterogenous debris | |
| | Heterogenous debris: | metals, mercury | Metal-contaminated debris | |
| Labpacks | Labpacks | Epoxy, uranium, acid, lead, thorium nitrate crystals | Laboratory waste packages | Incineration |
| Explosives | Wastewater sludge from explosives | Explosive contaminated solids, DMSO | Explosive-contaminated solids | Open Burning (non-Plutonium contaminated) |
| | Explosive contaminated support material | High-explosive residue, mercury | Explosive-contaminated solids | Aqueous washing, base hydrolysis, and chemical leaching |
| Liquid mercury | Not available | Liquid mercury | Waste stream residual from other groups | Plasma melting, chemical leaching, encapsulation, amalgamation, and recycle |
| Batteries (demilitarized and sanitized) | Batteries (demilitarized and sanitized) | Nickel cadmium | Batteries (demilitarized and sanitized) | Encapsulation, metal melting, and slagging |
| Compressed gases (aerosol containers) | Aerosol containers | Discarded paint cans | Discarded paint cans | Decontamination and disposal |

[a] Typical radionuclides that may be present in the mixed waste include uranium, thorium, and tritium.
Source: PX DOE 1993c.

**TABLE H.2.4–5.—*Mixed Low-Level Waste Inventory at Pantex***

| Treatability Group | Number of Waste Streams | Inventory as of April 15, 1994 ($yd^3$) | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|
| Aqueous liquids | 4 | 9 (1,810 gal) | 23 (4,600 gal) |
| Organic liquids | 2 | 5 (990 gal) | 10 (2,000 gal) |
| Inorganic solids | 3 | 30 | 4 |
| Soils | 1 | 0.2 | — |
| Debris | 7 | 120 | 390 |
| Lab packs | 3 | 14 | 14 |
| Elemental lead | 1 | 0.3 | 1 |
| Batteries | 1 | 0.2 | 10 |
| Compressed gases | 1 | 0.3 | 1 |
| **Total** | 23 | 179 | 452 |

Source: DOE 1994k; PX MH 1994d.

**TABLE H.2.4–6.—*Hazardous Waste Streams at Pantex Plant***

| Process | Generation | Constituents | Materials | Disposal/Storage Method |
|---|---|---|---|---|
| High explosives | Materials generated during manufacture machining and retirement. | High explosives | HE machining coolant fluid, HE waste scrap, retired HE components | Filtration, settlement, burning ground treatment, monitor and bury burn residue |
| Spent solvents-explosive, contaminated | Materials generated from chemicals used in synthesis and solvents used in formation of HE. | High explosives, solvents | Explosives contaminated spent solvents | Evaporate solvents and ignite residue at burning ground, disposal offsite at EPA/state approved site |
| Mercury contaminated waste | Materials generated in lab glassware during vacuum pull down and in following clean-up. | Mercury, vacuum pump oil | Mercury, vacuum pump oil, pump filter, paper waste, rags, gloves, other miscellaneous clean-up materials | Held for recycle or disposal at offsite EPA/State approved site |
| Explosive contaminated, solid waste | Materials generated during explosive processing. | High explosives | Explosives, contaminated mops, rags, wipes, boxes, and paper. | Burn at burning ground, monitor and bury in landfill |
| Chrome plating waste | Materials generated during chrome electroplating process in machine shop plating room. | Chromium | Chromium-contaminated spent chemicals | Filter chromium, monitor liquid and discharge to sanitary sewer, drum CrOH cakes for disposal at authorized site |
| Cleaning liquid compounds | Materials generated during parts cleaning operations at vehicle maintenance facility. | Petroleum Naphtha/ mineral spirits | Cleaning liquid compound | Offsite approval disposal |
| Immersion carburetor cleaner | Materials generated during vehicle carburetor cleaning. | Waste compound cleaning liquid | Carburetor cleaning liquid | Offsite reclamation |
| Miscellaneous discarded lab chemicals | Materials generated during lab operations, collected through a periodic sweep of labs. | Miscellaneous lab chemicals | Miscellaneous lab chemicals | Offsite approved disposal |
| Silver contaminated photo waste | Materials generated during photograph silver activities. | Photo chemicals | Silver contaminated photo chemicals, photo paper, recovery canisters | Reclamation of silver |
| Lead shields | Materials generated during removal of lead shields. | Lead | Lead shields | Sold as scrap lead |
| Radiator cleaner | Materials generated during vehicle radiator cleaning operations. | Sodium hydroxide | Radiator cleaner | Offsite approved disposal site |
| Paint waste | Materials generated during vehicle product and industrial maintenance. | Paint and paint sludge | Paint and paint sludge | Offsite approved recycler |
| Spent carbon | Materials generated during filtering explosives contaminated wastewater. | High explosives | Contaminated carbon filters | Burned at burning ground, ash to offsite approved disposal site |

Source: PX MH 1988a; PX MH 1990b.

### H.2.5 Savannah River Site

The process of manufacturing useful nuclear materials has produced radioactive, mixed, and hazardous wastes that are treated, stored, or disposed of on SRS. The *Environmental Restoration and Waste Management Five Year Plan Fiscal Year 1994-1998* (DOE/S-00097P), addresses the tasks of cleaning up existing waste units and bringing current operations into compliance with applicable regulations. It deals in detail with the current conditions and plans for remediation. It also addresses the development and funding of processes to minimize waste generation and to safely process and dispose of future waste generation.

**Pollution Prevention.** Pollution prevention, previously driven by best management practices and economics, is now mandated by statutes, regulations, and agency directives. The SRS Waste Minimization and Pollution Prevention Program is designed to achieve continuous reduction of wastes and pollutant releases to the maximum extent feasible and in accord with regulatory requirements while fulfilling national security missions. The SRS Waste Minimization and Pollution Prevention Awareness Plan addresses wastes and potential pollutants of all types and establishes priorities for accomplishing waste minimization and pollution prevention through source reduction, recycling, treatment, and environmentally safe disposal.

**Spent Nuclear Fuel.** Spent nuclear fuel is not designated as a waste and is not included in the waste inventory since, during processing, separation of useful isotopes from the spent nuclear fuel is accomplished, and only the remaining waste is classified as HLW, TRU, or LLW. DOE discontinued reprocessing spent nuclear fuel in 1992. DOE will make decisions concerning the treatment and stabilization of the current inventory of spent nuclear fuel after the completion of programmatic and site-specific reviews pursuant to the *National Environmental Policy Act.* SRS has been one of the receiving sites for returned domestic and foreign research reactor spent fuel. The preparation of production, commercial, and research reactor fuel for long-term storage and the receipt of fuel from offsite is addressed in the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Draft EIS* (DOE/EIS-0203-D) and the EIS on the proposed policy for the acceptance of U.S.-origin foreign research reactor spent fuel. There are 184 metric tons of production reactor spent fuel and targets and 17 metric tons of commercial, experimental, and research reactor spent fuel in storage at SRS (DOE 1994g:2-9).

**High-Level Waste.** Liquid HLW containing actinides and hazardous chemicals were generated from recovery and purification of transuranic products and from spent fuel processing, and retreivably stored in 51 underground tanks. (One of these tanks is out of service.) The waste is segregated by heat generation rate, neutralized to excess alkalinity, and stored to permit the decay of short-lived radionuclides before its volume is reduced by evaporation. Of the 51 tanks, 29 are located in the H-Area Tank Farm, and 22 are located in the F-Area Tank Farm. The tanks are of four different designs, but all are of carbon steel. Wastes are transferred to and processed in the newer tanks which have full height secondary containment and forced water cooling. Some older tanks contain old salt and sludge awaiting waste removal. Other old tanks have had waste removed except for residue, and are used to store low activity waste. The older tanks will be taken out of service when space in other tanks becomes available due to transfer to the Defense Waste Processing Facility.

High-heat liquid waste is stored for 1 to 2 years to allow decay of radionuclides before being processed through evaporators. Low-heat waste is sent directly to the evaporator feed tanks. Each tank farm has one evaporator that is used to reduce the volume of the water and concentrate the solids. A replacement higher capacity evaporator is planned which may be used in conjunction with the current evaporators. Liquids can be reduced to 25 to 33 percent of original volume and stored as salts or sludges. Cesium removal columns can operate in conjunction with the evaporators. The evaporators obtain decontamination factors of 10,000 to 100,000 and the cesium removal columns can obtain another 10 to 200 decontamination factors. Decontaminated liquids (overheads) are sent to the Effluent Treatment Facility for processing before being released to Upper Three Runs Creek. The concentrated salt solution is processed to remove radionuclides and the decontaminated solution is sent to the Defense Waste Pro-

cessing Facility: Saltstone Facility for solidification and storage onsite in the Saltstone Vaults.

The remaining sludges and salts contain the majority of the radionuclides, and are stored separately, awaiting vitrification. Prior to vitrification, salt would be precipitated in the In Tank Precipitation process. The precipitate and sludge would be fed into the vitrification process in the Defense Waste Processing Facility. The waste will be mixed with borosilicate glass and immobilized by melting and pouring the mixture into stainless steel cylinders. These cylinders will be stored in a shielded facility at the Defense Waste Processing Facility until a repository is available. Figure H.2.5–1 illustrates HLW management at SRS. Tables H.2.5–1, H.2.5–2 and H.2.5–3 list HLW inventories and treatment and storage facilities at SRS.

**Transuranic Waste.** All TRU waste currently being generated is stored in containers on aboveground storage pads. Older TRU wastes (prior to 1965) were buried in plastic bags and cardboard boxes in earthen trenches. Wastes containing more than 0.1 Ci per package were placed in concrete containers and buried. Wastes containing less than 0.1 Ci per package were buried unencapsulated in earthen trenches. Since 1974, TRU wastes containing more than 10 nCi/g have been stored in retrievable containers free of external contamination. Polyethylene lined galvanized drums containing more than 0.5 Ci are additionally protected by closure in concrete culverts.

Currently, approximately 85 percent of the TRU waste in storage is suspected of being contaminated with hazardous constituents. Presently, waste is characterized by onsite generators and is being stored prior to final disposal. TRU waste containing less than 100 nCi/g may be disposed of as LLW at SRS. Waste containing greater than 100 nCi/g and meeting the final WIPP waste acceptance criteria will be sent to WIPP, if WIPP is determined to be a suitable repository pursuant to the requirements of 40 CFR 191 and 40 CFR 268. Waste not meeting the acceptance criteria as currently packaged will be repackaged as necessary to meet the WIPP waste acceptance criteria. If additional treatment is necessary for disposal at WIPP, SRS would develop the appropriate treatment technology, or ship this waste to another facility for treatment. Studies are underway to solve the problem of high heat TRU waste which is unique to SRS. Wastes with high Pu-238 fractions generate too much heat to be shipped in the TRUPACT-II. TRU waste is currently stored on 17 pads at the Solid Waste Disposal Facility in the E-Area. The TRU waste management plan is illustrated in figure H.2.5–2. Table H.2.5–4 lists the mixed TRU waste inventories. Tables H.2.5–5 and H.2.5–6 present the TRU and mixed TRU waste treatment and storage facilities.

**Low-Level Waste.** Both liquid and solid LLW are treated at SRS. Liquids are processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points. The bulk of liquid waste is aqueous process waste including effluent cooling water, purge water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination.

Aqueous LLW streams are sent to the Effluent Treatment Facility where they are treated by filtration, reverse osmosis and ion exchange to remove the radionuclide contaminants. After treatment, the effluent is discharged to Upper Three Runs Creek. The resultant wastes are concentrated by evaporation and stored in the H-Area Tank Farm for eventual treatment in the Defense Waste Processing Facility: Saltstone Facility. In that facility, they will be processed with grout for onsite disposal. Figure H.2.5–3 illustrates the liquid LLW processing at SRS. Processing and disposal of solidified liquids is illustrated in figures H.2.5–4 and H.2.5–5. Inventory, treatment, and storage facilities for LLW and mixed LLW are listed in tables H.2.5–7, H.2.5–8, and H.2.5–9.

Disposal of solid LLW at the SRS traditionally has been accomplished using engineered trenches in accordance with the guidelines and technology existing at the time of disposal. The E-Area Vault project is a comprehensive effort for upgrading LLW disposal at SRS based on meeting the requirements of the current DOE orders, incorporating technological advances, and addressing more stringent Federal regulation and heightened environmental awareness. Four basic types of vaults/buildings are being constructed for the different waste categories: low-

activity waste vault, intermediate-level nontritium vault, intermediate-level tritium vault, and long-lived waste storage building.

The vaults are below-grade concrete structures and the storage building is a metal building on a concrete pad. Long-lived waste is being stored until a final disposition can be determined. Additional information on these facilities is given in table H.2.5–10.

Solid LLW is segregated into several categories to facilitate proper treatment, storage, and disposal. Solid LLW that radiates less than 200 mrem per hour at 5 cm from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem per hour at 5 cm, it is considered intermediate-activity waste. This waste is typically contaminated equipment from separations, reactors, or waste management facilities. Intermediate activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. Spent lithium-aluminum targets from tritium operations equipment is included in this waste. Long-lived waste is contaminated with long-lived isotopes that exceed the waste acceptance criteria for disposal. Resin contaminated with carbon-14 from reactor operations is an example. Excavated soil from radiological materials areas that is potentially contaminated soil and cannot be economically demonstrated to be uncontaminated is managed as suspect soil. Figure H.2.5–5 illustrates LLW management at SRS. Solid LLW typically consists of protective clothing, contaminated equipment, irradiated hardware that does contain spent fuel, spent lithium-aluminum targets (from tritium extraction), and spent deionizer resins. All LLW is disposed of in the Solid Waste Disposal Facility in the E-Area between the F- and H-Areas. Wastes are compacted and packaged for burial. The primary method of disposal of low-activity waste is burial in engineered low-level earthen trenches. Trenches are located above the water table in soil containing enough clay to maintain its integrity, in an area where surface runoff can be controlled. The trench floors are sloped to a sump to eliminate standing water. After emplacement, the waste containers are covered with a soil cap, planted with selected grasses, and graded to direct runoff away from the trench. Intermediate-level wastes are disposed of in poured-in-place, top loading below-grade facilities to achieve as close to a zero release criteria as possible. Monitoring wells are located near each disposed waste area to verify performance and to monitor groundwater in the vicinity of the vaults. The existing 195-acre burial ground is filled and new concrete lined facilities are under construction to meet future SRS requirements. As of June 1994, the total inventory of LLW disposed of at SRS is 980,000 $yd^3$ (DOE 1994n:SRS).

**Mixed Low-Level Waste.** Mixed LLW is in interim storage in the E- and G-Areas in various buildings in drums, concrete culverts, and metal boxes. These South Carolina Department of Health and Environmental Control-permitted facilities will remain in use until appropriate treatment and disposal is performed on the waste.

The planned and funded Hazardous/Mixed Waste Treatment and Disposal Facility will process both mixed and hazardous wastes. The mixed waste management plan for SRS, illustrated in figure H.2.5–7, is being reevaluated through the development of a Site Treatment Plan in accordance with the *Federal Facility Compliance Act* of 1992. Mixed waste inventories are listed in table H.2.5–7. Treatment facilities and processes are listed in table H.2.5–8. Storage facilities capacity and status are listed in tables H.2.5–9 and H.2.5–10.

**Hazardous Waste.** Typical hazardous wastes at SRS are lead, mercury, cadmium, 1,1,1-trichloro-ethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents. Figure H.2.5–6 illustrates the processing of hazardous wastes at SRS.

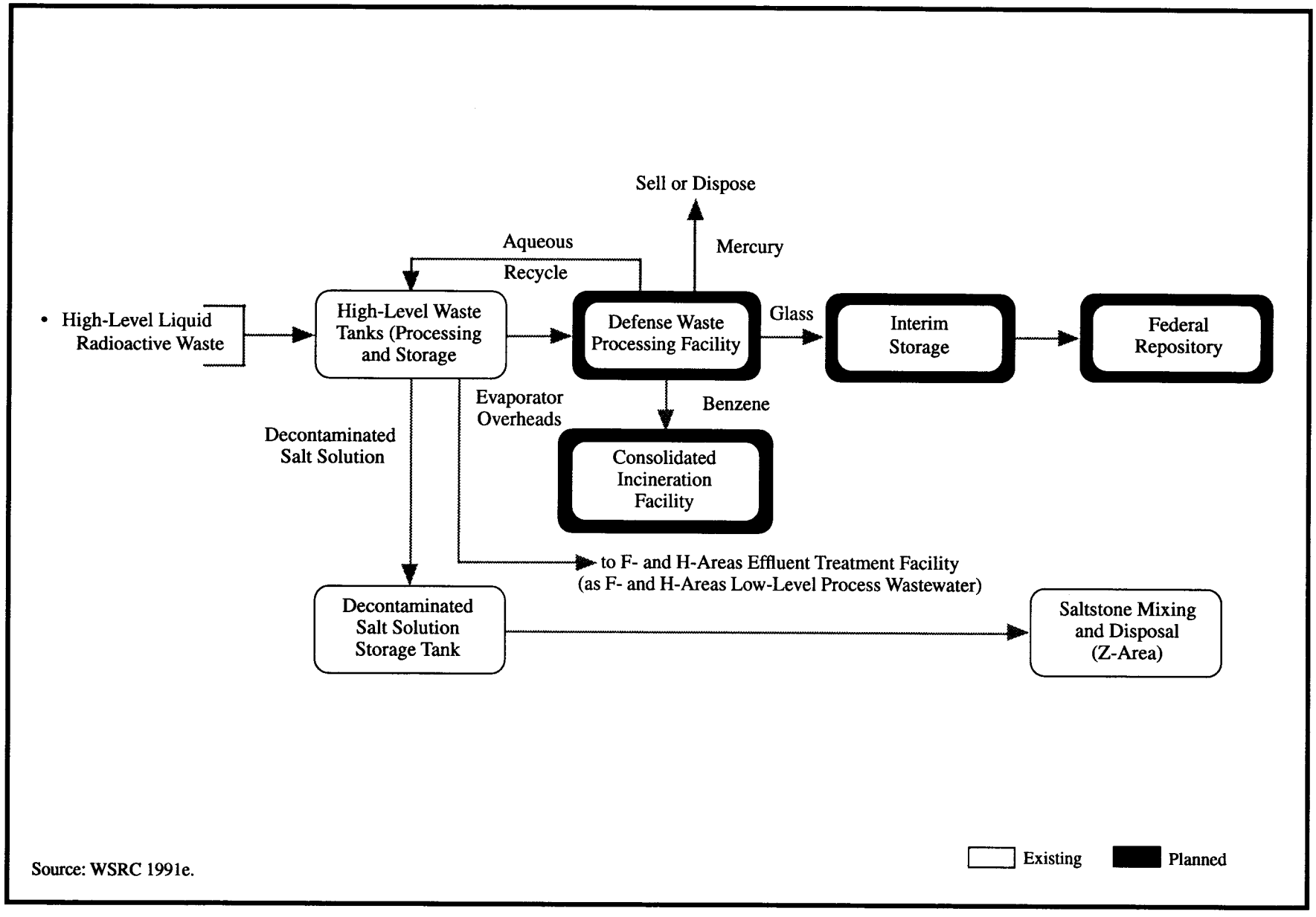
This waste is stored in three South Carolina Department of Health and Environmental Control-permitted buildings and facilities in the 700 area. One of these buildings is covered under a RCRA final permit. RCRA permits have been submitted for the other facilities. The buildings are constructed with sloped floors, dikes, and sumps to provide adequate containment in the event of a spill. Waste is stored in DOT-approved containers. Some of the waste is shipped to an offsite vendor for processing and disposal, thus allowing the site to maintain its current storage capabilities.

**Nonhazardous (Sanitary) Waste.** SRS operates its own sanitary waste landfill near road C, between C-3 and E. The first section of this landfill is at capacity, the second section reached capacity in 1993, and the

third (interim) section is expected to provide capacity until 1997. Waste minimization and disposal method improvements are being employed to more efficiently utilize the landfill. The open pit method is used, and wastes are weighed and recorded before being disposed of in the facility. This facility has been found to be a source of groundwater contamination in the past, and is operating under a South Carolina Department of Health and Environmental Control permit which was valid through 1994. It will be modified, if necessary, to adequately assess the impact of continued use of this landfill. In the future, SRS is planning to contract with offsite facilities for the disposal of its sanitary waste.

**Other Nonhazardous Waste.** SRS disposes of other nonhazardous wastes in addition to the nonhazardous wastes disposed of in the sanitary landfill. These wastes consist of scrap metal, powerhouse ash, domestic sewage, scrap wood, construction debris, and used railroad ties.

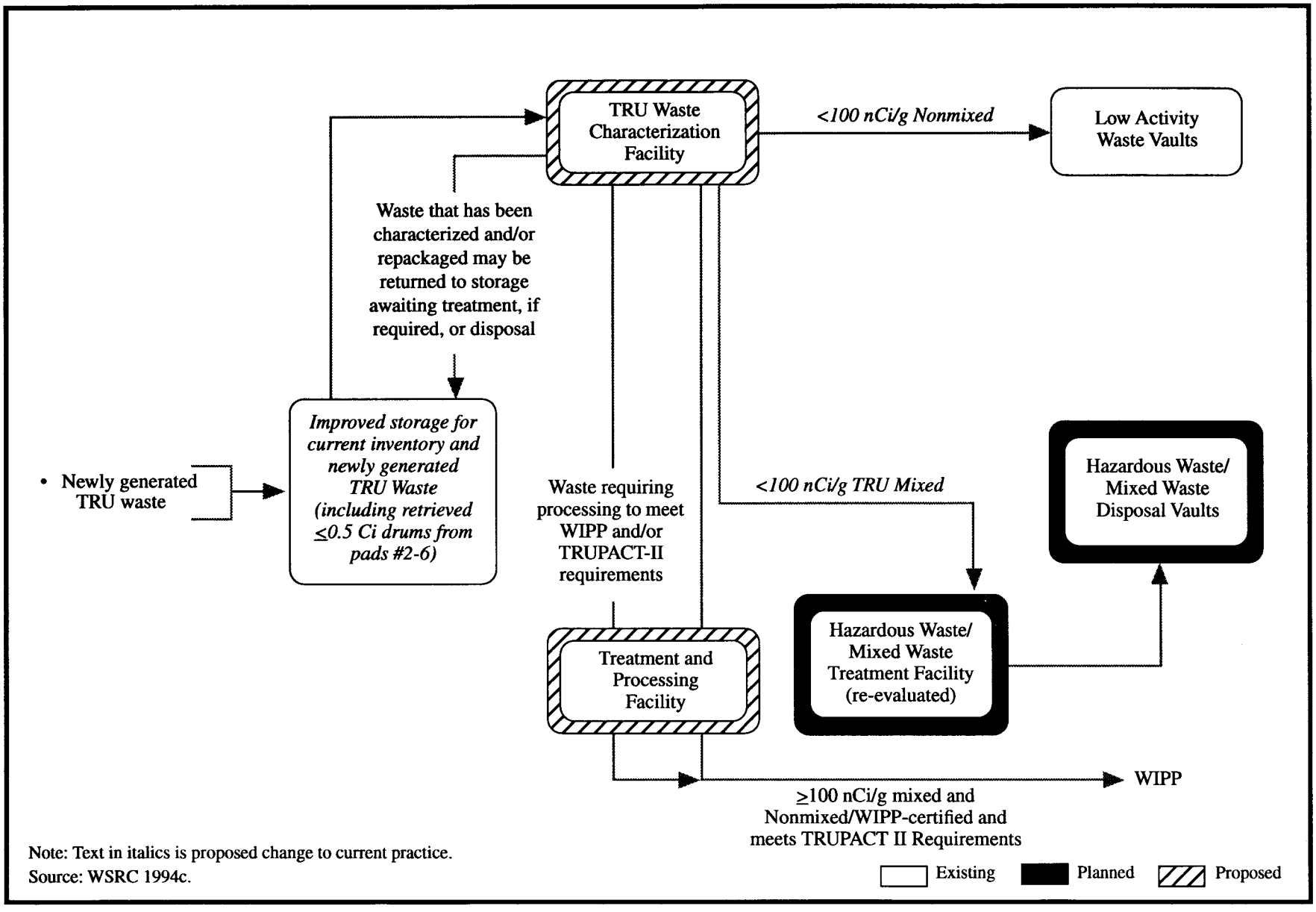
Scrap metal is sold to salvage vendors for reclamation. Powerhouse ash and domestic sewage sludge is used for land reclamation. Scrap wood is burned in the open. Construction debris is used for erosion control. Railroad ties have been processed into a biodegradable state. Nonhazardous waste management is illustrated in figure H.2.5–8.




Source: WSRC 1991e.

2143

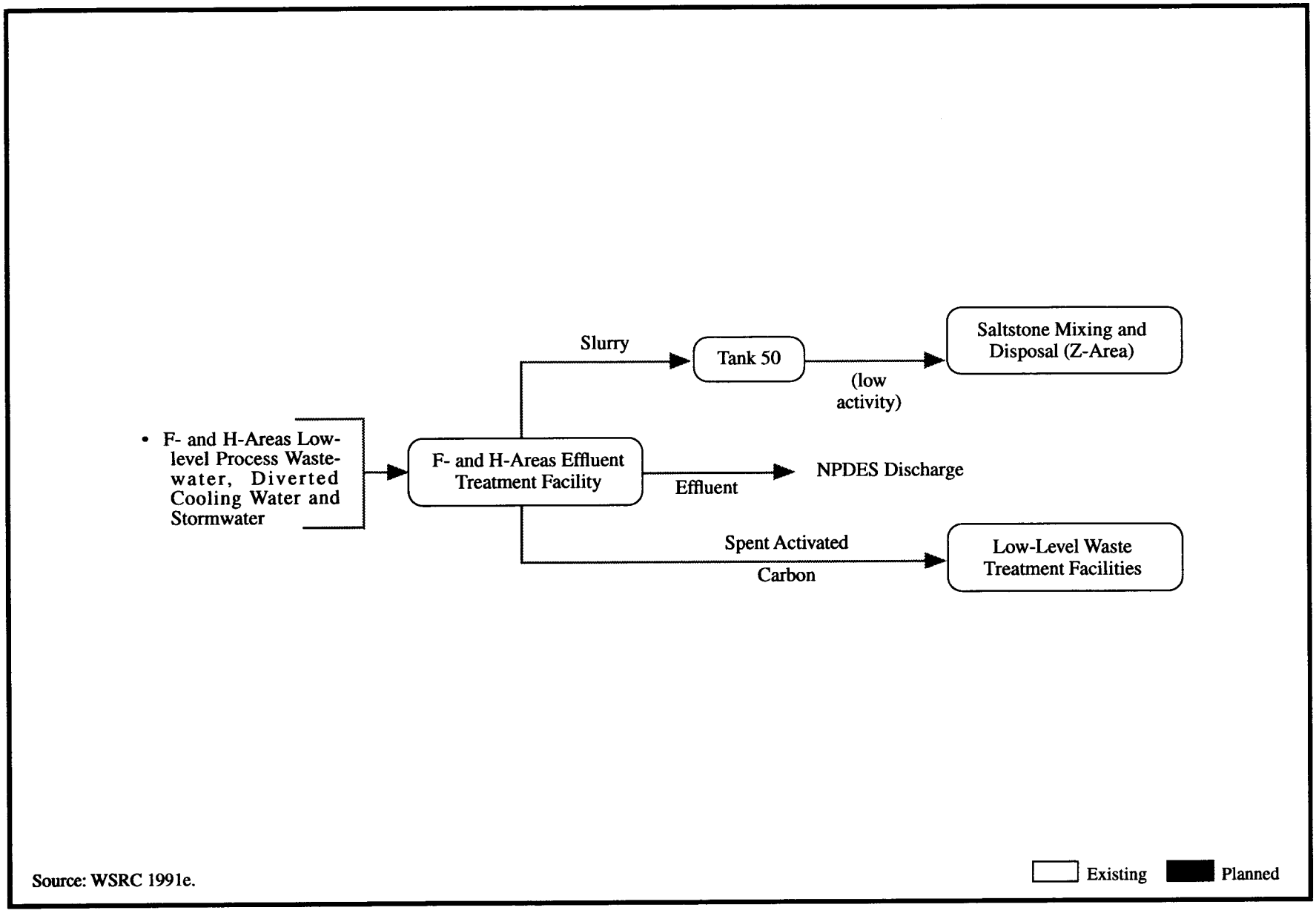
**FIGURE H.2.5–1.**—***High-Level Waste Management Plan at Savannah River Site.***




Note: Text in italics is proposed change to current practice.
Source: WSRC 1994c.

2144

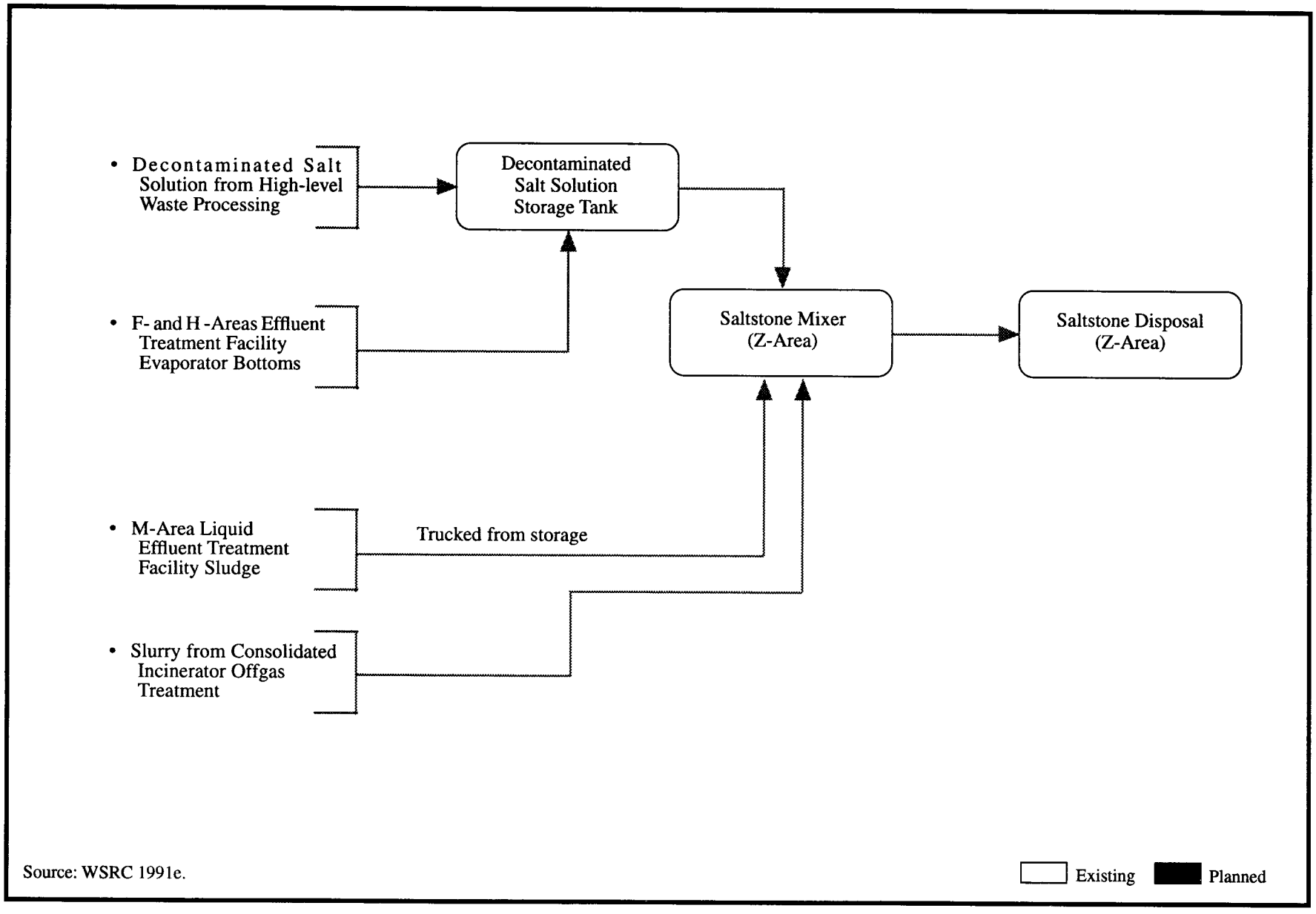
**FIGURE H.2.5–2.—*Transuranic Waste at Savannah River Site.***




Source: WSRC 1991e.

2148

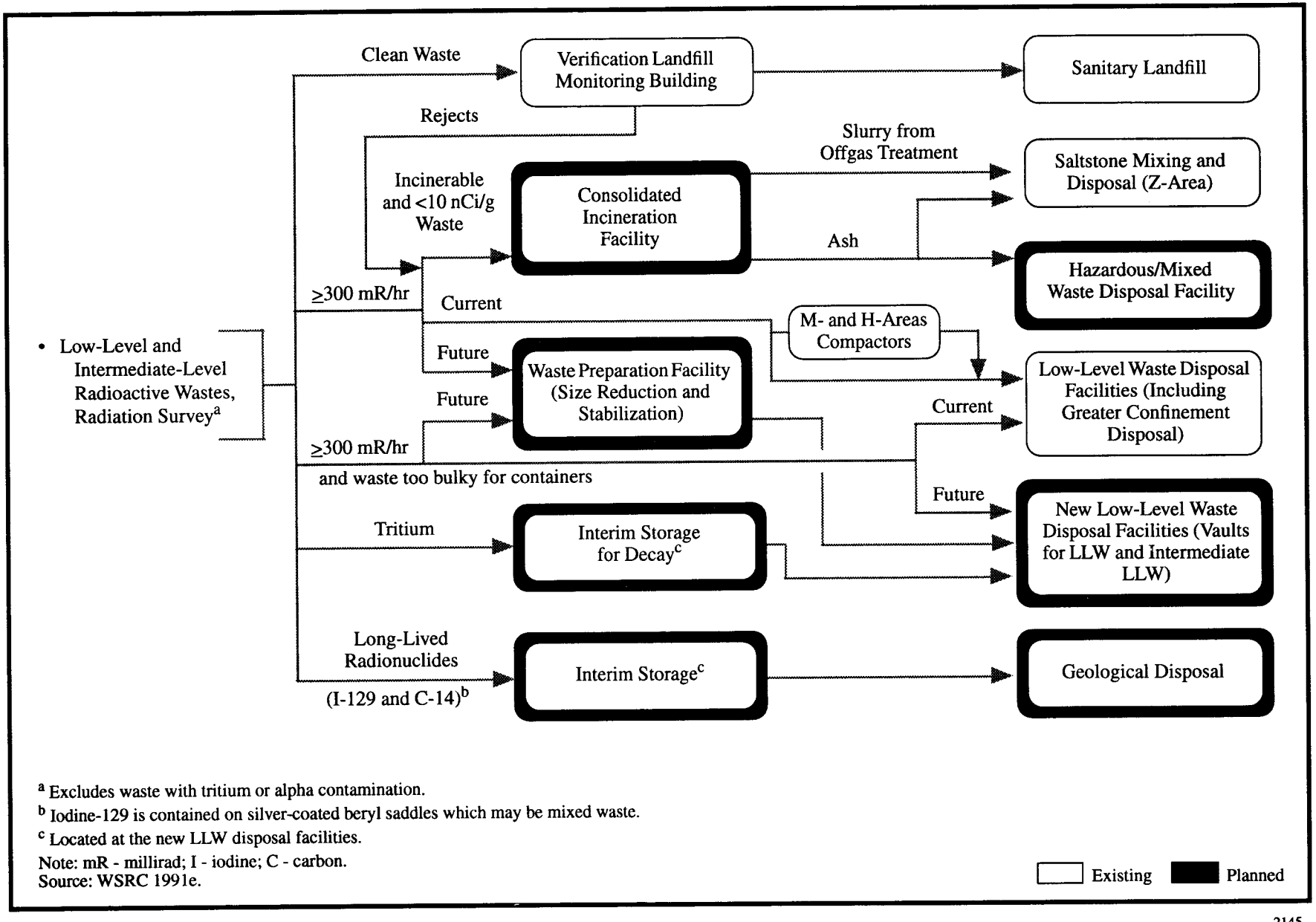
**FIGURE H.2.5–3.—*F- and H-Areas Effluent Treatment Facility Waste Management Plan at Savannah River Site.***




Source: WSRC 1991e.

**FIGURE H.2.5–4.**—***Saltstone (Low-Level Waste) Disposal Plan at Savannah River Site.***

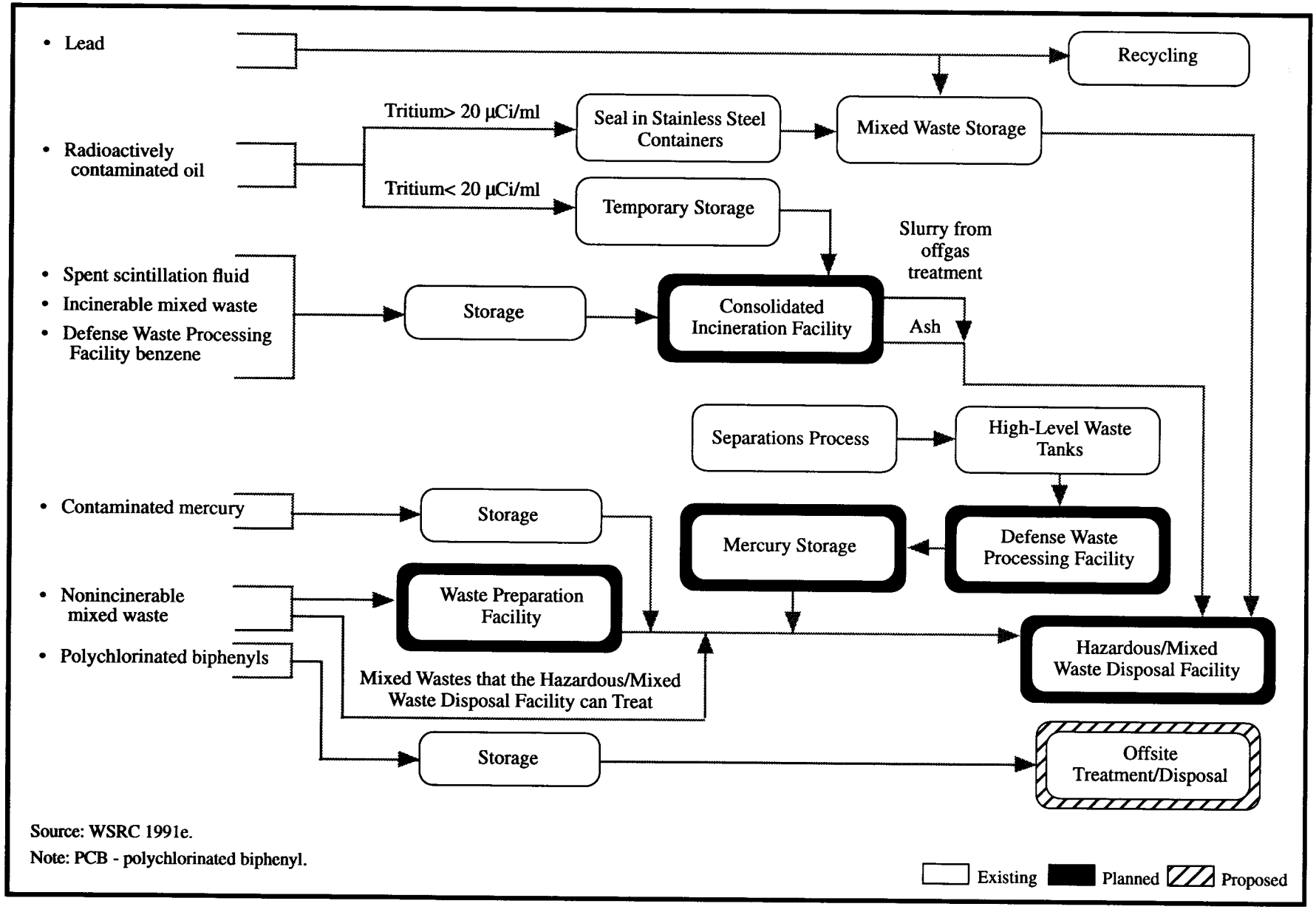
2149




[a] Excludes waste with tritium or alpha contamination.
[b] Iodine-129 is contained on silver-coated beryl saddles which may be mixed waste.
[c] Located at the new LLW disposal facilities.
Note: mR - millirad; I - iodine; C - carbon.
Source: WSRC 1991e.

2145

**FIGURE H.2.5–5.—*Low-Level Waste Management Plan at Savannah River Site.***

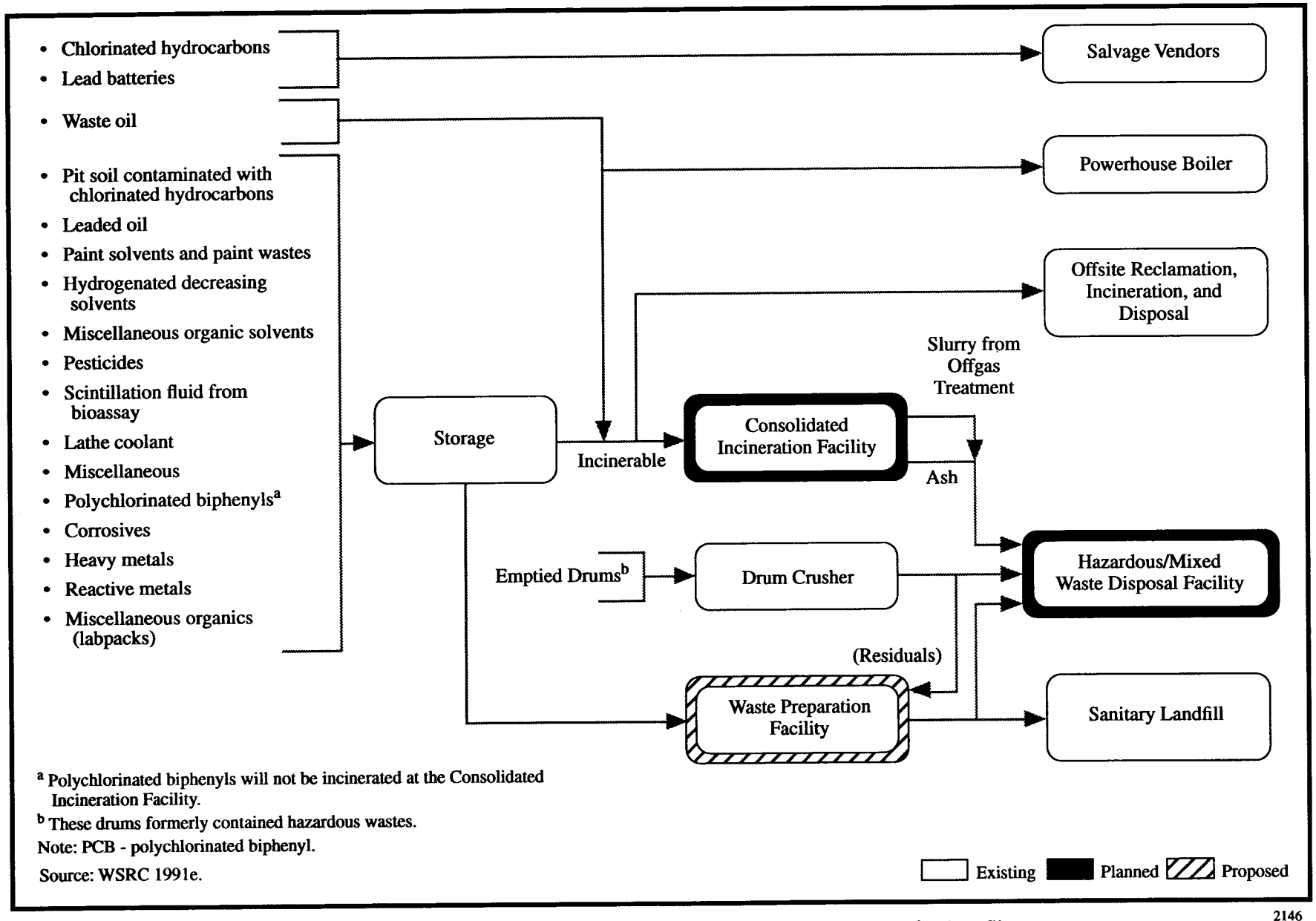



Source: WSRC 1991e.

Note: PCB - polychlorinated biphenyl.

**FIGURE H.2.5–6.—*Mixed Waste Management Plan at Savannah River Site.***

2147




[a] Polychlorinated biphenyls will not be incinerated at the Consolidated Incineration Facility.

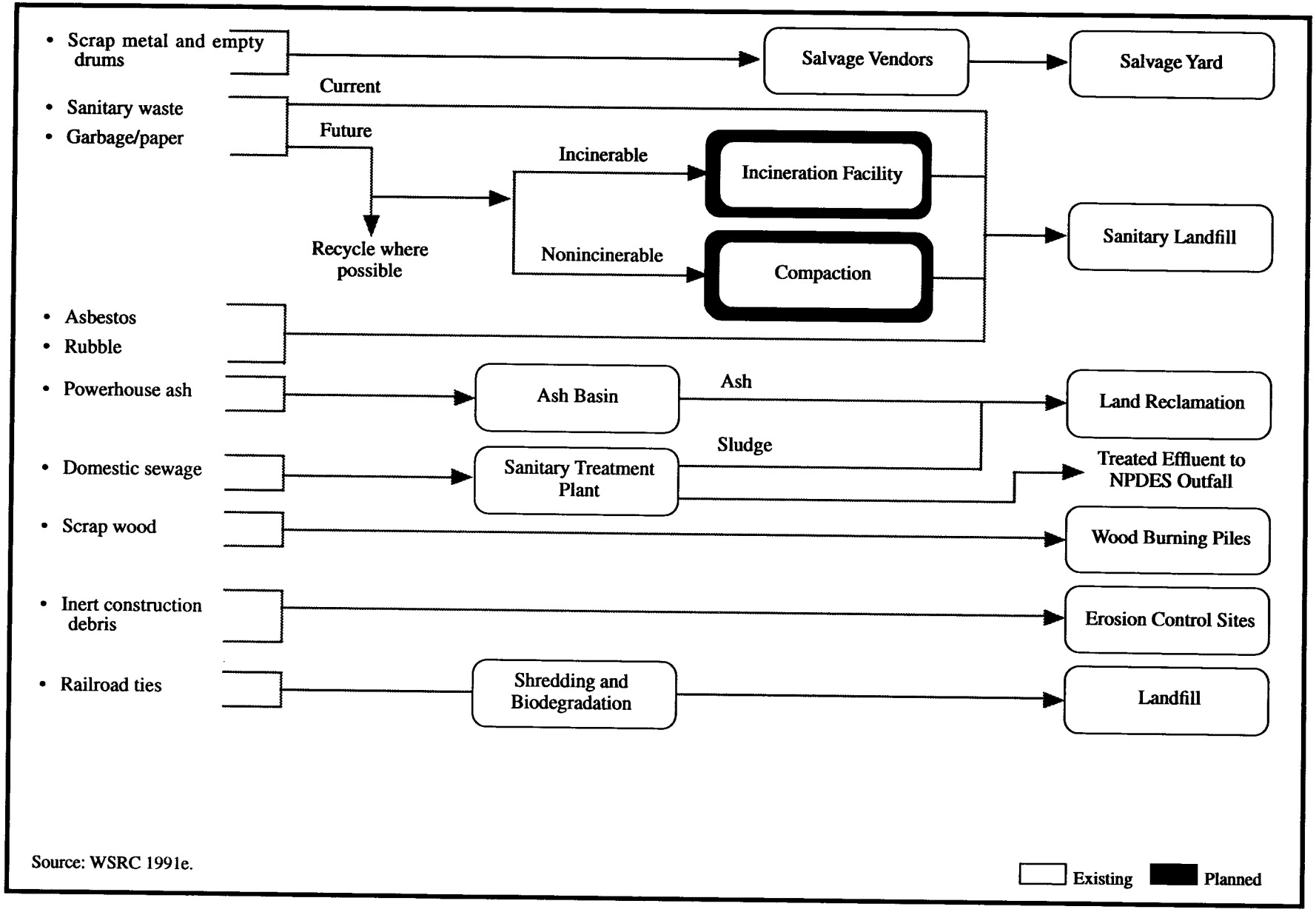
[b] These drums formerly contained hazardous wastes.

Note: PCB - polychlorinated biphenyl.

Source: WSRC 1991e.

2146

**FIGURE H.2.5–7.—*Hazardous Waste Management Plan at Savannah River Site.***




Source: WSRC 1991e.

**FIGURE H.2.5–8.**—***Nonhazardous Solid Waste Management Plan at Savannah River Site.***

2150

**TABLE H.2.5–1.—*High-Level Wastes at Savannah River Site***

| Waste Matrix | Number of Waste Streams | Inventory as of September 30, 1993 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Remote-handled** | | | | |
| Aqueous liquids, slurries | 3 | 167,900 (33,900,000 gal) | 3 | 17,800 (3,600,000 gal) |
| Inorganic non-metal Debris | 1 | 42 | 0 | 0 |
| **Total** | 4 | 167,900 | 3 | 17,800 |

Source: DOE 1994k; WSRC 1994a.

**TABLE H.2.5–2.—*High-Level Waste Treatment Capability at Savannah River Site***

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] ($yd^3$ per year) | Comment |
|---|---|---|---|---|---|
| F- and H-Tank Farms | Neutralization dissolution, chemical reaction | HLW aqueous liquid solutions and slurries | HLW aqueous liquid, sludge, solutions | [b] | Operational |
| Savannah River Technology Center high activity treatment probe | Ion exchange | HLW aqueous liquid | Mixed LLW liquid, HLW sludge | 16,934 (457,229 GPY) | Operational |
| F- and H-Evaporators | Evaporation, ion exchange (cesium removal) | HLW aqueous liquid | HLW sludge, salt, slurry, organic solid | 83,333[c] (2,250,000 GPY) | Operational |
| Replacement Evaporator | Evaporation, ion exchange (cesium removal) | HLW aqueous liquid | HLW sludge, salt, slurry, organic solid | 120,000 (3,240,000 GPY) | Planned for 1997 |
| Extended Sludge Processing | Decontamination | HLW sludge | HLW sludge | Dependent on tank inventory | Operational |
| In-Tank Precipitation | Precipitation, adsorption, filtration | HLW salt solution | HLW, LLW precipitate slurry | 190,000[c] (5,130,000 GPY) | Startup December 1994 |
| Defense Waste Processing Facility Vitrification Plant | Vitrification | HLW precipitate, sludge | HLW solid borosilicate glass | 8,570 (1,731,000 GPY) | Planned available March 1996 |

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies and permit issuance.

[b] Batch process; depends on available tanks and process used.

[c] Based on net tank space gained. Input volume.

Source: DOE 1993g; SR DOE 1993b; SR MMES 1993a; WSRC 1994b; WSRC 1994c.

**TABLE H.2.5–3.—*High-Level Waste Storage at Savannah River Site***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| F-Area Tank Farm[b] | HLW, corrosive, toxic aqueous liquids, salt, sludge | 64,400 (13,000,000 gal) | Operational |
| H-Area Tank Farm[b] | HLW, corrosive, toxic aqueous liquids, salt, sludge | 109,000 (22,100,000 gal) | Operational |
| **Total** | | 173,400 (35,100,000 gal) | |
| Defense Waste Processing Facility Vitrification Plant | HLW solid borosilicate glass in stainless steel cylinders | 2,826 | First unit available December 31, 1995 |
| Defense Waste Processing Facility Vitrification Plant | HLW solid borosilicate glass in stainless steel cylinders | 2,826 | Second unit planned. |
| **Total Solid** | | 5,652 | |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.
[b] Tanks that do not meet secondary containment criteria as described in the Federal facility agreement are not included.
Source: DOE 1993g; SR MMES 1993a; WSRC 1994a; WSRC 1994b.

**TABLE H.2.5–4.—*Mixed Transuranic Waste at Savannah River Site***

| Waste Matrix | Number of Waste Streams | Inventory as of September 30, 1993 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Organic liquids | 2 | 1.7 (343 gal) | 0 | 0 |
| Combustible debris | 2 | 6,570 | 1 | 267 |
| Ash | 1 | 0.1 | 0 | 0 |
| **Total** | 5 | 6,572 | 1 | 267 |

Source: DOE 1994k; WSRC 1994a.

**TABLE H.2.5–5.—*Transuranic and Mixed Transuranic Waste Treatment Capability at Savannah River Site***

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] | Comment |
|---|---|---|---|---|---|
| Transuranic Waste Facility | Sorting, shredding, grouting, sampling, venting, repackaging | Miscellaneous TRU, extraction procedure toxic, listed | Solid TRU in drums | Proposed facility | Proposed facility |

[a] For those facilities already in use this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.
Source: DOE 1993g; SR MMES 1993a.

**TABLE H.2.5–6.—*Transuranic and Mixed Transuranic Waste Storage at Savannah River Site***

| Storage Unit | Input Capability | Total Capacity ($yd^3$) | Comment |
|---|---|---|---|
| TRU Storage Pads | Miscellaneous solid TRU waste, extraction procedure toxic, listed | 22,900 | Operational RCRA Part A. No offsite waste planned. Buried waste to be exhumed, processed at TRU Waste Facility, and shipped to WIPP |

Source: DOE 1993g; SR MMES 1993a; WSRC 1994a.

**TABLE H.2.5–7.—*Mixed Low-Level Waste at Savannah River Site***

| Waste Matrix | Number of Waste Streams | Inventory as of September 30, 1993 ($yd^3$) | Number of Waste Streams Five-Year Projection | Total Generation Five-Year Projection ($yd^3$) |
|---|---|---|---|---|
| **Contact-handled** | | | | |
| Aqueous liquids/slurries | 6 | 130 (26,300 gal) | 3 | 1,504 (304,000 gal) |
| Organic liquids | 8 | 171 (34,500 gal) | 4 | 506 (102,000 gal) |
| Inorganic process residues | 10 | 2,931 | 4 | 654 |
| Debris | 2 | 1,584 | 0 | 0 |
| Metal debris | 4 | 147 | 1 | 4 |
| Combustible debris | 2 | 8 | 2 | 4 |
| Homogeneous debris | 4 | 3,662 | 2 | 36 |
| Lab packs | 1 | 0.2 | 0 | 0 |
| Reactive metals | 1 | 1 | 0 | 0 |
| Elemental mercury | 1 | 0.3 | 0 | 0 |
| Elemental lead | 1 | 226 | 1 | 78 |
| Vitrified forms | 0 | 0 | 1 | 654 |
| Ash, alpha | 0 | 0 | 1 | 81 |
| Uncategorized soils, alpha | 1 | 24 | 0 | 0 |
| **Remote-handled** | | | | |
| Inorganic process residues | 1 | 13 | 0 | 0 |
| Metal debris | 1 | 0.3 | 2 | 26 |
| **Total** | 42 | 8,358 | 21 | 3,551 |

Source: DOE 1994k; WSRC 1994a.

TABLE H.2.5–8.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Savannah River Site*

| Treatment Unit | Treatment Method | Input Capability | Output Capability | Total Capacity[a] ($yd^3$ per year) | comment |
|---|---|---|---|---|---|
| Consolidated Incineration Facility | Incineration | Mixed LLW, liquid, solid | Ash, slurry | 71,555 (14,455,000 GPY) | Planned, approved, RCRA final, available 1996 |
| Consolidated Incineration Facility Ashcrete | Stabilization | Mixed LLW, ash, slurry | Stabilized LLW, mixed LLW, solid | 30 | Planned, approved, RCRA final, available 1996 |
| F- and H-Areas Effluent Treatment Facility | Neutralization, chemical precipitation, filtration, carbon adsorption, reverse osmosis, ion exchange, evaporation, mercury adsorption | Mixed LLW, aqueous liquids (F&H Area wastewater, evaporator overheads and condensate, cesium removal column effluent, etc.) | Corrosive LLW liquid concentrate, treated water effluent; used activated carbon, used ion exchange resins (solid LLW) | 311,882 (63,000,000 GPY) | Operational, NPDES: Operating |
| H-Area Compactor | Compaction | Solid LLW job waste | Compacted LLW | 36,624 | Operational |
| Hazardous/Mixed Waste Treatment/ Disposal Facility | Distillation, electrochemical, encapsulation, solidification, precipitation, size reduction, amalgamation, stabilization | Liquids and solids, mixed LLW, toxic, corrosive, reactive, metal, sludge | Wastewater, solid stabilized LLW | 1,163 (234,926 GPY) | Planned, approved, availability unknown |
| M-Area Compactor | Compaction | Solid LLW job waste | Compacted LLW | 36,624 | Operational |
| M-Area Dilute Effluent Treatment Facility | Filtration, neutralization, precipitation | Liquid mixed LLW | Wastewater, solid mixed LLW | 130,080 (26,000,000 GPY) | Operational, NPDES: operating |
| M-Area Vendor Treatment Facility | Vitrification | Aqueous liquids and slurries, mixed LLW | Wastewater, solid mixed LLW | 1,960 (396,000 GPY) | Planned, approved, NPDES: construction, available 1995 |
| Savannah River Technology Center Ion Exchange Treatment Probe Low Activity | Ion exchange | Mixed LLW, aqueous liquids | Aqueous liquid, solid, mixed LLW | 1,960 (396,000 GPY) | Operational, RCRA: interim |
| Z-Area Saltstone Facility | Stabilization (solidification with radio-nuclide binders) | Liquids, mixed LLW, sludges, toxic, corrosive | Solid LLW, nonhazardous | 12,400 (2,500,000 GPY) | Operational, permitted disposal, CWA, RCRA: final |

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1993g; DOE 1994k; SR DOE 1993b; SR MMES 1993a.

**TABLE H.2.5–9.—*Low-Level and Mixed Low-Level Waste Storage at Savannah River Site***

| Storage Unit | Input Capability | Total Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Burial Ground Solvent Tanks (523-31) | Liquid mixed LLW | 990 (200,000 gal) | To be closed, RCRA Part A |
| Defense Waste Processing Facility Organic Waste Storage Tank (430-3) | Liquid mixed LLW, ignitable, toxic | 743 (150,000 gal) | Operational, RCRA Part A |
| Liquid Waste Solvent Tanks (533-36) | Liquid mixed LLW | 990 (200,000 gal) | Proposed facility |
| M-Area Process Waste Interim Treatment/Storage Facility | Liquid mixed LLW, listed, (electroplate sludge) | 10,900 (2,200,000 gal) | Operational, RCRA Part A |
| Mixed Waste Storage Buildings (643-29E and 643-43E) | Liquid mixed LLW solid, toxic, listed, ignitable, metal, sludge, soil | 1,690 (341,000 gal) | Operational, RCRA Part A |
| Mixed Waste Storage Shed (316-M) | Liquid and solid mixed LLW | 153 (30,800 gal) | Operational, RCRA Part A |
| Savannah River Laboratory High Activity Storage Tanks (772-2A) | Liquid mixed LLW, toxic, Toxicity Characteristic Leaching Procedure | 259 (52,300 gal) | Operational, RCRA Part A |
| Hazardous Waste Storage Facility (645-2N) | Mixed LLW | 761 (154,000 gal) | Operational, RCRA Part B |
| **Totals** | | 16,486 (3,300,000 gal) | |

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.
Source: WSRC 1994b.

**TABLE H.2.5–10.—*Waste Disposal at Savannah River Site***

| Disposal Unit | Input Capability | Capacity[a] ($yd^3$) | Comment |
|---|---|---|---|
| Hazardous/Mixed Waste Disposal Vaults | Solid mixed LLW, listed (CIF, Ashcrete and blowdown) | 3,920 | Planned and funded, RCRA submitted 1990, available 2000. |
| Intermediate-Level Waste Vaults | Solid LLW | 8,060 | Under construction |
| Low- and Intermediate-Level Disposal Area | Solid LLW | 994,000[b] | Operational |
| Low Activity Waste Vaults | Solid LLW, compacted waste, contaminated equipment, filters, sediment, job control waste, process beds, soils, resins, lithium-aluminum melted forms | 44,000 | Under construction |
| Z-Area Saltstone Vaults | Solid LLW | 1,491,000 | 15 vaults operational, additional 27 vaults planned |

[a] Schedules and capacities for the facilities under design or construction are subject to changes such as availability of funds and permit issuance.
[b] 40,500 $yd^3$ remaining as of June 1994.
Source: DOE 1992f; DOE 1994n; SR DOE 1993b; SR MMES 1993a.

# APPENDIX I

# Appendix I

# APPENDIX I: COMPARISON OF ENVIRONMENTAL IMPACTS OF THE TRITIUM SUPPLY AND RECYCLING ALTERNATIVES

## I.1 Comparison of Tritium Supply and Recycling Alternatives

A comparison of the environmental consequences of the tritium supply and recycling alternatives is summarized in table I.1–1. This table compares the impacts to each environmental resource associated with No Action, and tritium supply technologies and recycling at each of the five candidate sites. Section 3.2 presents the possible alternatives in more detail.

The table I–1 format presents the impacts of alternatives by resource or issue under two subcategories: collocated tritium supply and recycling; and tritium supply alone. Also included in the comparison table are impacts associated with "less than baseline operations" (see section 3.1). At the end of each resource or issue is a subsection which discusses the impacts of phasing out the recycling mission at Savannah River Site (SRS) if any one of the tritium supply technologies with a new recycling facility is selected at that site. For example, if an HWR is collocated with recycling at INEL, the tritium recycling mission at SRS would be phased out and must be considered as part of the action at INEL. The tritium recycling phaseout discussion applies to any collocated tritium supply and recycling at all sites except SRS. Likewise, if a tritium supply alone is sited at INEL, the recycling facility at SRS would be upgraded as part of the action at INEL. At SRS there are no tritium supply alone alternatives since tritium recycling is already at SRS and would be upgraded if a tritium supply were sited there. Therefore, the impacts for alternatives at SRS consist only of tritium supply and upgraded recycling. The tritium recycling upgrade is part of the tritium supply alone alternatives at the other four candidate sites (INEL, NTS, Oak Ridge Reservation (ORR) and Pantex).

Under No Action, the Department of Energy (DOE) would not establish a new tritium supply capability, the current inventory of tritium would decay and DOE would not meet stockpile requirements of tritium. Sites would continue waste management programs to meet the legal requirements and commitments in formal agreements and would proceed with cleanup activities. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for the year 2010 and beyond. The current DOE missions assumed to continue under No Action are listed in section 3.3 for each candidate site.

**TABLE I.1–1.—*Comparison of Tritium Supply and Recycling Alternatives***

**Land Resources**

| Technology | INEL | NTS |
|---|---|---|
| **No Action (2010)** | • No impacts to land use or visual resources. | • No impacts to land use or visual resources. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Construction would require 462 acres and operation would require 456 acres, which represents 0.09 percent of the available land. This use would be consistent with the INEL Landlord Site Development Plan and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. | • **Collocated Tritium Supply and Recycling**—Construction would require 462 acres and operation would require 456 acres, which represents 0.5 percent of the available land. This use would be consistent with the NTS Site Development Plan and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The VRM classification of the proposed site would change from Class 2 to Class 5. Depending on the final siting, the facilities may be visible from a portion of the Desert National Wildlife Range, a sensitive viewpoint about 10 to 13 miles away. |
| | • **Tritium Supply Alone**—Construction and operation would require 260 acres which represents 0.05 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 260 acres which represents 0.3 percent of the available land. Impacts would be the same as above. |
| | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—Construction would require 562 acres and operation would require 556 acres, which represents 0.1 percent of the available land. This use would be consistent with the INEL Landlord Site Development Plan and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. | • **Collocated Tritium Supply and Recycling**—Construction would require 562 acres and operation would require 556 acres, which represents 0.6 percent of the available land. This use would be consistent with the NTS Site Development Plan and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The VRM classification of the proposed site would change from Class 2 to Class 5. Depending on the final siting, the facilities may be visible from a portion of the Desert National Wildlife Range, a sensitive viewpoint about 8 miles away. |
| | • **Tritium Supply Alone**—Construction and operation would require 360 acres which represents 0.06 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 360 acres which represents 0.4 percent of the available land. Impacts would be the same as above. |
| | • **Less Then Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Then Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. |

**Land Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No impacts to land use or visual resources. | • No impacts to land use or visual resources. | • No impacts to land use or visual resources. |
| • **Collocated Tritium Supply and Recycling**—Construction would require 462 acres and operation would require 456 acres, which represents 2.1 percent of the available land. A portion of this land is designated as National Environmental Research Park. Prime farmland or other agricultural activities would not be affected. The facilities would be visible from several highly sensitive viewpoints along high traffic volume roads in the area. The VRM classification of the proposed site would change from Class 4 to Class 5. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. | • **Collocated Tritium Supply and Recycling**—Construction would require 462 acres and operation would require 456 acres, which represents 45 percent of industrial site A, 34 percent of B, 29 percent of C, and 3.3 percent of the total available land. The only land use impact would be the displacement of existing agricultural uses on soils classified as prime farmland. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would require 260 acres which represents 0.1 percent of the available land. Prime farmland, agricultural activities, onsite or offsite land uses, or special study areas would not be affected. The VRM classification of the proposed site would change from Class 4 to Class 5, but the overall appearance of SRS would be unchanged from key sensitive viewpoints. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. |
| • **Tritium Supply Alone**—Construction and operation would require 260 acres which represents 1.2 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 260 acres which represents 1.9 percent of the available land. Impacts would be the same as above. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Construction would require 562 acres and operation would require 556 acres, which represents 2.6 percent of the available land. A portion of this land is designated as National Environmental Research Park. Prime farmland or other agricultural activities would not be affected. The facilities would be visible from several highly sensitive viewpoints along high traffic volume roads in the area. The VRM classification of the proposed site would change from Class 4 to Class 5. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. | • **Collocated Tritium Supply and Recycling**—Construction would require 562 acres and operation would require 556 acres, which represents 62 percent of industrial site A, 47 percent of B, 40 percent of C, and 4 percent of the total available land. The only land use impact would be the displacement of existing agricultural uses on soils classified as prime farmland. The existing visual landscape character would remain unchanged with a VRM classification of Class 4. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would require 360 acres which represents 0.2 percent of the available land. Prime farmland, agricultural activities, onsite or offsite land uses, or special study areas would not be affected. The VRM classification of the proposed site would change from Class 4 to Class 5, but the overall appearance of SRS would be unchanged from key sensitive viewpoints. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. |
| • **Tritium Supply Alone**—Construction and operation would require 360 acre which represents 1.7 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 360 acres which represents 2.6 percent of the available land. Impacts would be the same as above. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be expected to be the same as above for the tritium supply and upgraded recycling facility. |

**Land Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Construction would require 552 acres and operation would require 546 acres for the Large and Small ALWR, which represents 0.1 percent of the available land. This use would be consistent with the INEL Landlord Site Development Plan and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. | • **Collocated Tritium Supply and Recycling**—Construction would require 552 acres and operation would require 546 acres for the Large and Small ALWR, which represents 0.6 percent of the available land. This use would be consistent with the NTS Site Development Plan and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The VRM classification of the proposed site would change from Class 2 to Class 5. Depending on the final siting, the facilities may be visible from a portion of the Desert National Wildlife Range, a sensitive viewpoint approximately 10–13 miles away. |
| | • **Tritium Supply Alone**—Construction and operation would require 350 acres which represents 0.06 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 350 acres which represents 0.4 percent of the available land. Impacts would be the same as above. |
| | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Construction would require 375 acres and operation would require 369 acres, which represents 0.07 percent of the available land. This use would be consistent with the INEL Landlord Site Development Plan, and would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. The APT would be the least visually obtrusive technology since it consists of mostly low profile structures. | • **Collocated Tritium Supply and Recycling**—Construction would require 375 acres and operation would require 369 acres, which represents 0.4 percent of the available land. This use would be consistent with the NTS Site Development Plan, would not affect prime farmland, grazing allotments, other agricultural activities, or onsite or offsite land uses. The VRM classification of the proposed site would change from Class 2 to Class 5. Depending on the final siting, the facilities may be visible from a portion of the Desert National Wildlife Range, a sensitive viewpoint approximately 10 to 13 miles away. The APT would be the least visually obtrusive technology since it consists of mostly low profile structures. |
| | • **Tritium Supply Alone**—Construction and operation would require 173 acres which represents 0.03 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 173 acres which represents 0.2 percent of the available land. Impacts would be the same as above. |

**Land Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling**—Construction would require 552 acres and operation would require 546 acres for the Large and Small ALWRs, which represents 2.5 percent of the available land. A portion of this land is designated as National Environmental Research Park. These acreages represent 2.5 percent of the available land. Prime farmland or other agricultural activities would not be affected. The facilities would be visible from several highly sensitive viewpoints along high traffic volume roads in the area. The VRM classification of the proposed site would change from Class 4 to Class 5. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. | • **Collocated Tritium Supply and Recycling**—Construction would require 552 acres and operation of the Large and Small ALWRs would require 546 acres, which represents 60 percent of industrial site A, 46 percent of B, 39 percent of C, and 3.9 percent of the total available land. The only land use impact would be the displacement of existing agricultural uses on soils classified as prime farmland. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would require 350 acres for the Large and Small ALWRs which represents 0.2 percent of the available land. Prime farmland, agricultural activities, onsite or offsite land uses, or special study areas would not be affected. The VRM classification of the proposed site would change from Class 4 to Class 5, but the overall appearance of SRS would be unchanged from key sensitive viewpoints. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. |
| • **Tritium Supply Alone**—Construction and operation would require 350 acres which represents 1.6 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 350 acres which represents 2.5 percent of the available land. Impacts would be the same as above. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Construction would require 375 acres and operation would require 369 acres, which represents 1.7 percent of the available land. A portion of this land is designated as National Environmental Research Park. These acreages represent 1.7 percent of the available land. Prime farmland or other agricultural activities would not be affected. The facilities would be visible from several highly sensitive viewpoints along high traffic volume roads in the area. The VRM classification of the proposed site would change from Class 4 to Class 5. The APT would be the least visually obtrusive technology since it consists of mostly low profile structures. | • **Collocated Tritium Supply and Recycling**—Construction would require 375 acres and operation would require 369 acres, which represents 30 percent of industrial site A, 23 percent of B, 19 percent of C, and 2.6 percent of the total available land. The only land use impact would be the displacement of existing agricultural uses on soils classified as prime farmland. The existing visual landscape characteristics would remain unchanged with a VRM classification of Class 4. The APT would be the least visually obtrusive technology since it consists of mostly low profile structures. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would require 173 acres and represents 0.1 percent of the available land. Prime farmland, agricultural activities, onsite or offsite land uses, or special study areas would not be affected. The overall appearance of SRS would be unchanged from key sensitive viewpoints. Use of a wet cooling system would result in visible plumes during certain atmospheric conditions. The VMR classification of the proposed site would change from Class 4 to Class 5. The APT would be the least visually obtrusive technology since it consists of mostly low profile structures. |
| • **Tritium Supply Alone**—Construction and operation would require 173 acres which represents 0.8 percent of the available land. Impacts would be the same as above. | • **Tritium Supply Alone**—Construction and operation would require 173 acres which represents 1.2 percent of the available land. Impacts would be the same as above. | • **No Tritium Supply Alone.** |

**Land Resources**

| Technology | INEL | NTS |
|---|---|---|
| | • **Less Then Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Then Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would not impact land resources at the site. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would not impact land resources at the site. |
| **Site Infrastructure** | | |
| **No Action (2010)** | • Reduction of 51 MWe in the peak electrical load requirement. Annual energy consumption would remain the same. | • Reduction of 7 MWe in the peak electrical load requirement. Annual energy consumption would remain the same. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Operation would require 8 miles of additional onsite roads and 2 miles of railroads. The additional electrical load requirement would increase the sites peak requirement by 85 MWe and the annual consumption by 628,000 MWh per year. However, this would only exceed the current peak capacity of the site by 34 MWe and would utilize 0.62 percent of the regional power pools capacity margin. Six miles of new onsite transmission lines would increase consumption by approximately 115 percent. The coal requirement would not increase. | • **Collocated Tritium Supply and Recycling**—Operation would require 2 miles of additional onsite roads. Should a railroad connection be needed, 120 miles of new rail and railbed would be required. The additional electrical load requirement would increase the sites peak requirement by 85 MWe and the annual consumption by 628,000 MWh per year. However, this would only exceed the current peak capacity of the site by 78 MWe and would utilize 0.72 percent of the regional power pools capacity margin. Sixty-two miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 116 percent. |
| | • **Tritium Supply Alone**—Annual energy consumption would reduce by 88,000 MWh per year with a decrease in peak load of 16 MWe from above. The fuel oil requirement would reduce by 96,000 gal per year. | • **Tritium Supply Alone**— Annual energy consumption would reduce by 88,000 MWh per year with a decrease in peak load of 16 MWe from above. The fuel oil requirement would reduce by 96,000 gal per year. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. |

## Land Resources

| ORR | Pantex | SRS |
|---|---|---|
| • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts would be expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would not impact land resources at the site. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would not impact land resources at the site. | • **No Tritium Recycling Phasout with SRS Alternatives.** |
| **Site Infrastructure** | | |
| • Reduction of 1,304 MWe in the peak electrical load requirement and 11,641,800 MWh per year in the annual energy consumption. Consumption of natural gas and fuel oil would reduce by 122 million $ft^3$ per year and 80,600 gal per year respectively, with an increase in coal consumption of 10,000 tons per year. | • Reduction of 1 MWe in the peak electrical load requirement and 7,000 MWh per year in the annual energy consumption. Consumption of natural gas and fuel oil would reduce by 50 million $ft^3$ per year and 14,000 gal per year respectively. | • Reduction of 214 MWe in the peak electrical load requirement and 878,000 MWh per year in the annual energy consumption. |
| • **Collocated Tritium Supply and Recycling**—Operation would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 67 MWe and the annual consumption by 458,000 MWh per year. However, this would be 1,237 MWe less than the sites current peak capacity and would utilize 1.47 percent of the regional power pools capacity margin. No new onsite transmission lines would be required. The additional natural gas and fuel oil requirements would increase consumption by approximately 9 and 15 percent, respectively. The coal requirement would not increase. | • **Collocated Tritium Supply and Recycling**—Operation would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 85 MWe and the annual consumption by 628,000 MWh per year. However, this would only exceed the current peak capacityof the site by 84 MWe and would utilize 0.64 percent of the regional power pools capacity margin. Nine miles of onsite transmission lines would need to be rerouted and connected to a new electrical substation. The additional natural gas and fuel oil requirements would increase consumption by approximately 53 and 51 percent, respectively. | • **Tritium Supply and Upgraded Recycling**—Operation would require an additional 6 miles of onsite roads and 6 miles of railroads. The additional electrical load requirement would increase the sites peak requirement by 51 MWe and the annual consumption by 370,000 MWh per year. However, this would be 163 MWe less than the site current peak capacity and would utilize 0.49 percent of the regional power pools capacity margin. Existing onsite transmission lines and facilities would need to be upgraded for the increased and redistributed electrical load. The additional fuel oil requirement would increase consumption by approximately 69 percent and the coal requirement would not increase. However, the overall increase in sitewide BTU consumption is only approximately 4 percent. |
| • **Tritium Supply Alone**—Annual energy consumption would reduce by 88,000 MWh per year with a decrease in peak load of 16 MWe from above. The natural gas and fuel oil requirements would reduce by 7 million $ft^3$ per year and 50,000 gal per year respectively. | • **Tritium Supply Alone**—Annual energy consumption would reduce by 88,000 MWh per year with a decrease in peak load of 16 MWe from above. The natural gas and fuel oil requirements would reduce by 7 million $ft^3$ per year and 50,000 gal per year respectively. | • **No Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facilities. |

**Site Infrastructure**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**— Operation would require 8 miles of additional onsite roads and 2 miles of railroads. The additional electrical load requirement would increase the sites peak requirement by 62 MWe and the annual consumption by 448,000 MWh per year. However, this would only exceed the sites current peak capacity by 11 MWe and would utilize 0.45 percent of the regional power pools capacity margin. Six miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 14 percent. The coal requirement would not increase. | • **Collocated Tritium Supply and Recycling**— Operation would require 2 miles of additional onsite roads. Should a railroad connection be needed, 120 miles of new rail and railbed would be required. The additional electrical load requirement would increase the sites peak requirement by 62 MWe and the annual consumption by 448,000 MWh per year. However, this would only exceed the sites current peak capacity by 55 MWe and would utilize 0.53 percent of the regional power pools capacity margin. Sixty-two miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 14 percent. |
| | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The fuel oil requirement would decrease by 96,000 gal per year. | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The fuel oil requirement would decrease by 96,000 gal per year. |
| | • **Less Than Baseline Operations**— Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**— Impacts are expected to be the same as for the collocated supply and recycling. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**— Operation of the Large and Small ALWRs would require 8 miles of additional onsite roads and 2 miles of railroads for both. The additional electrical load requirement would increase the sites peak requirement by 156 MWe or 91 MWe and the annual consumption by 1,188,000 MWh per year or 668,000 MWh per year, respectively. However, this would only exceed the current peak capacity of the site by 105 MWe or 40 MWe for the two size reactors. The Large and Small options of the ALWR would use either 1.14 or 0.67 percent of the regional power pools capacity margin. Six miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 20 or 14 percent respectively. The coal requirement would not increase for either ALWR. | • **Collocated Tritium Supply and Recycling**—Operation would require 2 miles of additional onsite roads. Should a railroad connection be needed, 120 miles of new rail and railbed would be required. The additional electrical load requirement would increase the peak requirement by 156 MWe or 91 MWe and the annual consumption by 1,188,000 MWh per year or 668,000 MWh per year respectively. However, this would only exceed the current peak capacity by 149 MWe or 84 MWe for the two size reactors. The Large and Small options of the ALWR would use either 1.32 or 0.77 percent of the regional power pools capacity margin. Sixty-two miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 20 or 14 percent, respectively. |

**Site Infrastructure**

| ORR | Pantex | SRS |
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| • **Collocated Tritium Supply and Recycling**—Operation would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 52 MWe and the annual consumption by 348,000 MWh per year. However, this would be 1,252 MWe less than the sites current peak capacity and would utilize 1.14 percent of the regional power pool capacity margin. No new onsite transmission lines would be required. The additional natural gas and fuel oil requirements would increase consumption by less than 1 percent and approximately 15 percent respectively. The coal requirement would not increase. | • **Collocated Tritium Supply and Recycling**—Operation would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 62 MWe and the annual consumption by 448,000 MWh per year. However, this would only exceed the sites current peak capacity by 61 MWe and would utilize 0.47 percent of the regional power pools capacity margin. Nine miles of onsite transmission lines would need to be rerouted and connected to a new electrical substation. The additional natural gas and fuel oil requirements would increase consumption by approximately 3 and 51 percent respectively. | • **Tritium Supply and Upgraded Recycling**—Operation would require an additional 6 miles of onsite roads and 6 miles of railroads. The additional electrical load requirement would increase the sites peak requirement by 36 MWe and the annual consumption by 260,000 MWh per year. However, this would be 178 MWe less than the sites current peak capacity and would utilize 0.35 percent of the regional power pools capacity margin. Existing onsite transmission lines and facilities would need to be upgraded for the increased and redistributed electrical load. The additional fuel oil requirement would increase consumption by approximately 5 percent. The coal requirement would not increase. |
| • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The natural gas and fuel oil requirements would decrease by 7 million $ft^3$ per year and 50,000 gal per year respectively. | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The natural gas and fuel oil requirements would decrease by 7 million $ft^3$ per year and 50,000 gal per year respectively. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the tritium supply and upgraded recycling facilities. |
| • **Collocated Tritium Supply and Recycling**—Operation of the Large and Small ALWRs would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 112 MWe or 68 MWe and the annual consumption by 788,000 MWh per year or 468,000 MWh per year, respectively. However, this would be 1,192 MWe or 1,236 MWe less than the sites current peak capacity for the two size reactors. The Large and Small options of the ALWR would use either 2.46 or 1.50 percent of the regional power pools capacity margin. No new onsite transmission lines would be required. The additional natural gas requirement would increase consumption by less than one percent for both reactors. The additional fuel oil requirement would increase consumption by approximately 28 or 18 percent, respectively. The coal requirement would not increase for either ALWR. | • **Collocated Tritium Supply and Recycling**—Operation of the Large and Small ALWRs would require no additional onsite roads or railroads. The additional electrical load requirement would increase the peak requirement by 156 MWe or 91 MWe and the annual consumption by 1,188,000 MWh per year or 668,000 MWh per year, respectively. However, this would only exceed the current peak capacity by 155 MWe or 90 MWe for the two size reactors. The Large and Small options of the ALWR would use either 1.18 or 0.69 percent of the regional power pool capcaity margin. Nine miles of onsite transmission lines would need to be rerouted and connected to a new electrical substation. The additional natural gas requirement would increase consumption by approximately 2 percent for both reactors and the additional fuel oil requirement would increase consumption by approximately 96 or 62 percent respectively. | • **Tritium Supply and Upgraded Recycling**—Operation would require an additional 6 miles of onsite roads and 6 miles of railroads. The additional electrical load requirement would increase the peak requirement by 96 MWe or 52 MWe and the annual consumption by 700,000 MWh per year or 380,000 MWh per year, respectively. However, this would be 118 MWe or 162 MWe less than the sites current peak capacity for the two size reactors. The Large and Small options of the ALWR would use either 0.92 or 0.50 percent of the regional power pool capcaity margin. Existing onsite transmission lines and facilities would need to be upgraded for the increased and redistributed electrical load. The additional fuel oil requirement would increase consumption by approximately 9 or 5 percent, respectively. The coal requirement would not increase for either ALWR. |

| Technology | Site Infrastructure: INEL | Site Infrastructure: NTS |
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| **Advanced Light Water Reactor (Continued)** | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The fuel oil requirement would decrease by 96,000 gal per year. | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The fuel oil requirement would decrease by 96,000 gal per year. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Operation would require 11 miles of additional onsite roads and 2 miles of railroads. The additional electrical load requirement would increase the sites peak requirement by 566 MWe and the annual consumption by 3,828,000 MWh per year. However, this would only exceed the current sites peak capacity by 515 MWe and would utilize 4.15 percent of the regional power pools capacity margin. Six miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 7 percent. The coal requirement would not increase. | • **Collocated Tritium Supply and Recycling**—Operation would require 4 miles of additional onsite roads. Should a railroad connection be needed, 120 miles of new rail and railbed would be required. The additional electrical load requirement would increase the sites peak requirement by 566 MWe and the annual consumption by 3,828,000 MWh per year. However, this would only exceed the sites current peak capacity by 559 MWe and would utilize 4.79 percent of the regional power pools capacity margin. Sixty-two miles of new onsite transmission lines would be required. The additional fuel oil requirement would increase consumption by approximately 7 percent. |
| | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The fuel oil requirement would decrease by 96,000 gal per year. | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The fuel oil requirement would decrease by 96,000 gal per year. |
| | • **Less Than Baseline Operations**—Except for electrical consumption, impacts are expected to remain the same as for the collocated supply and recycling. The Phased APT would use approximately 40 percent less electricity as the Full APT but would still increase the sites peak requirement by 371 MWe and the annual consumption by 2,488,000 MWh per year. However, this would only exceed the sites current peak capacity by 320 MWe and would utilize 2.72 percent of the regional power pool capcity margin. | • **Less Than Baseline Operations**—Except for electrical consumption, impacts are expected to remain the same as for the collocated supply and recycling. The Phased APT would use approximately 40 percent less electricity as the Full APT but would still increase the sites peak requirement by 371 MWe and the annual consumption by 2,488,000 MWh per year. However, this would only exceed the sites current peak capacity by 364 MWe and would utilize 3.14 percent of the regional power pools capacity margin. |

**Site Infrastructure**

| ORR | Pantex | SRS |
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| • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The natural gas and fuel oil requirements would decrease by 7 million $ft^3$ per year and 50,000 gal per year, respectively. | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The natural gas and fuel oil requirements would decrease by 7 million $ft^3$ per year and 50,000 gal per year, respectively. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as for the tritium supply and upgraded recycling facilities. |
| • **Collocated Tritium Supply and Recycling**—Operation would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 566 MWe and the annual consumption by 3,828,000 MWh per year. However, this would be 738 MWe less than the sites current peak capacity and would utilize 12.44 percent of the regional power pools capacity margin. No new onsite transmission lines would be required. The additional natural gas and fuel oil requirements would increase consumption by less than percent and approximately 7 percent respectively. The coal requirement would not increase. | • **Collocated Tritium Supply and Recycling**—Operation would require no additional onsite roads or railroads. The additional electrical load requirement would increase the sites peak requirement by 566 MWe and the annual consumption by 3,828,000 MWh per year. However, this would only exceed the sites current peak capacity by 565 MWe and would utilize 4.28 percent of the regional power pools capacity margin. Nine miles of onsite transmission lines would need to be rerouted and connected to a new electrical substation. The additional natural gas and fuel oil requirements would increase consumption by approximately 2 and 25 percent, respectively. | • **Tritium Supply and Upgraded Recycling**—Operation would require an additional 9 miles of onsite roads and 6 miles of railroads. The additional electrical load requirement would increase the sites peak requirement by 550 MWe and the annual consumption by 3,740,000 MWh per year. However, this would only exceed the sites current peak capacity by 336 MWe and would utilize 5.27 percent of the regional power pools capacity margin. Existing onsite transmission lines and facilities would need to be upgraded for the increased and redistributed electrical load. The additional fuel oil requirement would increase consumption by less than one percent. The coal requirement would not increase. |
| • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The natural gas and fuel oil requirements would decrease by 7 million $ft^3$ per year and 50,000 gal per year, respectively. | • **Tritium Supply Alone**—Operation power requirements would be reduced by 88,000 MWh per year with a decrease in peak load of 16 MWe. The natural gas and fuel oil requirements would decrease by 7 million $ft^3$ per year and 50,000 gal per year, respectively. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Except for electrical consumption, impacts are expected to remain the same as for the collocated supply and recycling. The Phased APT would use approximately 40 percent less electricity as the Full APT but would still increase the sites peak requirement by 371 MWe and the annual consumption by 2,488,000 MWh per year. However, this would be 933 MWe less than the sites current peak capacity and would utilize 8.15 percent of the regional power pools capacity margin. | • **Less Than Baseline Operations**—Except for electrical consumption, impacts are expected to remain the same as for the collocated supply and recycling. The Phased APT would use approximately 40 percent less electricity as the Full APT but would still increase the peak requirement by 371 MWe and the annual consumption by 2,488,000 MWh per year. However, this would only exceed the current peak capacity by 370 MWe and would utilize 2.80 percent of the regional power pools capacity margin. | • **Less Than Baseline Operations**—Except for electrical consumption, impacts are expected to remain the same as for the tritium supply and upgraded recycling. The Phased APT would use approximately 40 percent less electricity than the Full APT but would still increase the sites peak requirement by 355 MWe and the annual consumption by 2,400,000 MWh per year. However, this would only exceed the sites current peak capacity by 155 MWe and would utilize 3.40 percent of the regional power pools capacity margin. |

**Site Infrastructure**

| Technology | INEL | NTS |
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| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would reduce the requirements for electrical current, current available electrical resources, fuel oil, and coal by 203 MWe, 1,037,000 MWh per year, 60,000 GPY, and 5,200 tons per year, respectively. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would reduce the requirements for electrical current, current available electrical resources, fuel oil, and coal by 203 MWe, 1,037,000 MWh per year, 60,000 GPY, and 5,200 tons per year, respectively. |
| **Air Quality and Acoustics** | | |
| **No Action (2010)** | • Air quality or acoustics impacts would not differ substantially from what presently occurs at the site. | • Air quality or acoustics impacts would not differ substantially from what presently occurs at the site. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |
| | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. |
| | • **Less Than Baseline Operations**—Air emissions would be slightly reduced but negligible from those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. | • **Less Than Baseline Operations**—Air emissions would be slightly reduced but negligible from those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |

**Site Infrastructure**

| ORR | Pantex | SRS |
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| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would reduce the requirements for electrical current, current available electrical resources, fuel oil, and coal by 203 MWe, 1,037,000 MWh per year, 60,000 GPY, and 5,200 tons per year, respectively. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would reduce the requirements electrical current, current available electrical resources, fuel oil, and coal by 203 MWe, 1,037,000 MWh per year, 60,000 GPY, and 5,200 tons per year, respectively. | • **No Tritium Recycling Phaseout with SRS Alternatives.** |
| **Air Quality and Acoustics** | | |
| • Air quality or acoustics impacts would not differ substantially from what presently occurs at the site. | • Air quality or acoustics impacts would not differ substantially from what presently occurs at the site. | • Air quality or acoustics impacts would not differ substantially from what presently occurs at the site. |
| • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Tritium Supply and Upgraded Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |
| • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Air emissions would be slightly reduced but negligible from those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. | • **Less Than Baseline Operations**—Air emissions would be slightly reduced but negligible from those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. | • **Less Than Baseline Operations**—Emissions would be slightly reduced but negligible from those described above from baseline operations. There would be no change in noise levels. |
| • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Tritium Supply and Upgraded Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |

**Air Quality and Acoustics**

| Technology | INEL | NTS |
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| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced and negligible. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced and negligible. |
| | • **Less Than Baseline Operations**—Air emissions from the two-reactor-module would be reduced by one-third. Noise impacts would not change due to less than baseline operations. | • **Less Than Baseline Operations**—Air emissions from the two-reactor-module would be reduced by one-third. Noise impacts would not change due to less than baseline operations. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Construction activities for the Large or Small ALWR would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities for the Large or Small ALWR would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Pollutant concentrations would increase during operation but would be within standards. |
| | • For both the Large or Small ALWR, an increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • For both the Large or Small ALWR, an increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |
| | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. |
| | • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. | • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |

## Air Quality and Acoustics

| ORR | Pantex | SRS |
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| • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Air emissions from the two-reactor-module would be reduced by one-third. Noise impacts would not change due to less than baseline operations. | • **Less Than Baseline Operations**—Air emissions from the two-reactor-module would be reduced by one-third. Noise impacts would not change due to less than baseline operations. | • **Less Than Baseline Operations**—Emissions would be slightly reduced but negligible from those described above for baseline operations. There would be no change in noise levels. |
| • **Collocated Tritium Supply and Recycling**—Construction activities for the Large or Small ALWR would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities for the Large or Small ALWR would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Tritium Supply and Upgraded Recycling**—Construction activities for the Large or Small ALWR would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| • For both the Large or Small ALWR, an increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • For both the Large or Small ALWR, an increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • For both the Large or Small ALWR, an increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |
| • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. | • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change during less than baseline operations. | • **Less Than Baseline Operations**—Emissions would be slightly reduced but negligible from those described above for baseline operations. There would be no change in noise levels. |
| • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ and TSP standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Collocated Tritium Supply and Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. | • **Tritium Supply and Upgraded Recycling**—Construction activities would result in exceedances of 24-hour ambient $PM_{10}$ standards at peak times and in dry and windy conditions. All other pollutants would be within standards. Air pollutant concentrations would increase during operation but would be within standards. |
| • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. | • An increase in noise would result from construction and operation. Increases would not be expected to cause annoyance to the public. |

**Air Quality and Acoustics**

| Technology | INEL | NTS |
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| **Accelerator Production of Tritium (Continued)** | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. |
| | • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change due to less than baseline operations. | • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change due to less than baseline operations. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The air emissions contribution from recycling activities at SRS is so low that the reduction due to phaseout would not be measurable. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The air emissions contribution from recycling activities at SRS is so low that the reduction due to phaseout would not be measurable. |
| **Water Resources** | | |
| **No Action (2010)** | • No impacts to water resources. | • No impacts to water resources. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |
| | • Groundwater use would increase by approximately 23 MGY (1 percent) during construction and by 62 MGY (3 percent) during operation. The total groundwater use would represent 18 percent of the groundwater allotment during construction and operation, respectively. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. | • Groundwater use would increase by approximately 23 MGY (4 percent) during construction and by 62 MGY (8 percent) during operation. Withdrawals during operation would not exceed the lowest estimated aquifer recharge rate. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. |

## Air Quality and Acoustics

| ORR | Pantex | SRS |
|---|---|---|
| • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **Tritium Supply Alone**—Construction and operation air emissions would be slightly less than those expected from the collocated supply and recycling. Noise levels would also be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change due to less than baseline operations. | • **Less Than Baseline Operations**—Air emissions would be the same as those described above for the collocated supply and recycling. Noise impacts would not change due to less than baseline operations. | • **Less Than Baseline Operations**—Emissions would be slightly reduced but negligible from those described above for baseline operations. There would be no change in noise levels. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The air emissions contribution from recycling activities at SRS is so low that the reduction due to phaseout would not measurable. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The air emissions contribution from recycling activities at SRS is so low that the reduction due to phaseout would not measurable. | • **No Tritium Recycling Phaseout with SRS Alternatives.** |
| **Water Resources** | | |
| • No impacts to water resources. | • No impacts to water resources. | • No impacts to water resources. |
| • **Collocated Tritium Supply and Recycling**—Surface water use would increase by approximately 23 MGY (1 percent) during construction and by 5,937 MGY (321 percent) during operation. Total site surface water use would represent 0.2 percent and 0.7 percent of the flow of the primary source during construction and operation, respectively. Approximately 17 MGY of additional nonhazardous and/or sanitary wastewater generated during construction and 61 MGY during operation would be discharged to surface waters. Blowdown discharges to surface waters would be approximately 2,304 MGY, which could increase the flow of the receiving waters by 7.3 percent. Blowdown discharges are not expected to impact permitted water quality discharge levels. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation. Approximately 17 MGY of nonhazardous and/or sanitary wastewater generated during construction and 53 MGY during operation would be discharged to playas. These represent increases of approximately 9 percent and 33 percent change in flow of wastewater to playas. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Tritium Supply and Upgraded Recycling**—No surface water would be used during construction, but use would increase by approximately 5,830 MGY during operation. This represents approximately an 29 percent increase in use and 2 percent of the flow of the primary source. Approximately 17 MGY of additional nonhazardous and sanitary wastewater generated during construction and 63 MGY during operation would be discharged to surface waters. These represent increases of approximately 1 percent and 5 percent in stream flow. Blowdown discharges to surface waters would be approximately 2,304 MGY, which could increase the flow of the receiving waters by 6,134 percent. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |
| • No groundwater would be used during construction or operation. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. | • Groundwater use would increase by 23 MGY (8 percent) during construction and by 62 MGY (17 percent) during operation. Drawdowns during operation could affect aquifer water levels. There would be no direct discharges to groundwater, but treated wastewater discharged to playas could percolate into the groundwater. | • Groundwater use would increase by 21 MGY (1 percent) during construction and by 69 MGY (2 percent) during operation. Drawdown impacts are not expected. There would be no discharges to groundwater and impacts to groundwater quality are not expected. |

**Water Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • There would be no impacts associated with floodplains. | • There are no designated floodplains at NTS however, a 500-year floodplain assessment would be required. |
| | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on the surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on the surface waters during construction and operation. |
| | • Groundwater use would increase by approximately 19 MGY (1 percent) during construction and by 44 MGY (2 percent) during operation. Total groundwater use would represent about 18 percent of the groundwater allotment during construction and operation, respectively. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. | • Groundwater use would increase by approximately 19 MGY (3 percent) during construction and by 44 MGY (5 percent) during operation. Withdrawals during operation would not exceed the lowest estimated aquifer recharge rate. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. |

**Water Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. |
| • **Tritium Supply Alone**—Total surface water requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharge to surface waters would decrease by 0.9 MGY. | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharge to playas would decrease 0.9 MGY during construction and 4.5 MGY during operation. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Surface water use would increase by approximately 19 MGY (1 percent) during construction and by 4,067 MGY (220 percent) during operation. Total site surface water use would represent 0.2 percent and 0.5 percent of the flow of the primary source during construction and operation, respectively. Approximately 15 MGY of additional nonhazardous and/or sanitary wastewater generated during construction and 43 MGY during operation would be discharged to surface waters. Blowdown discharges to surface waters would be approximately 1,608 MGY, which could increase the flow of the receiving waters by 5.1 percent. Blowdown discharges are not expected to impact permitted water quality discharge levels. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation. Approximately 15 MGY of nonhazardous and/or sanitary wastewater generated during construction and 35 MGY during operation would be discharged to playas. These represent increases of approximately 8 percent and 19 percent. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Tritium Supply and Upgraded Recycling**—No surface water would be used during construction, but would increase by approximately 4,030 MGY during operation. This represents approximately a 20 percent increase in use and 2 percent of the flow of the primary source. Approximately 14 MGY of additional nonhazardous and sanitary wastewater generated during construction and 45 MGY during operation would be discharged to surface waters. These represent increases of approximately 1 percent and 3 percent in stream flow. Blowdown discharges to surface waters would be approximately 1,608 MGY, which could increase the flow of the receiving waters by 4,270 percent. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |
| • No groundwater would be used during construction or operation. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. | • Groundwater use would increase by 19 MGY (7 percent) during construction and by 44 MGY (10 percent) during operation. Drawdowns during operation could affect aquifer water levels. There would be no direct discharges to groundwater, but treated wastewater discharged to playas could percolate into the groundwater. | • Groundwater use would increase by 18 MGY (1 percent) during construction and by 51 MGY (2 percent) during operation. Drawdown impacts are not expected. There would be no discharges to groundwater, and impacts to groundwater quality are not expected. |

**Water Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • There would be no impacts associated with floodplains. | • There are no designated floodplains at NTS, however a 500-year floodplain assessment would be required. |
| | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. |
| | • **Less Than Baseline Operations**—Impacts to surface water and groundwater quality are expected to be the same as above for the collocated supply and recycling. The two-reactor-module MHGTR would require and discharge one third the water. | • **Less Than Baseline Operations**—Impacts to surface water and groundwater quality are expected to be the same as above for the collocated supply and recycling. The two-reactor-module MHGTR would require and discharge one third the water. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation for either the Large or Small ALWRs, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation for either the Large or Small ALWRs, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |

**Water Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. |
| • **Tritium Supply Alone**—Total surface water requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharge to surface waters would decrease by 0.9 MGY. | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharge to playas would decrease 0.9 MGY during construction and 4.5 MGY during operation | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Surface water use would increase by approximately 35 MGY (2 percent) during construction and by 16,037 MGY (867 percent) during operation for the Large ALWR and 22 MGY (1 percent) during construction and 7,237 MGY (391 percent) for the Small ALWR. Total site surface water use would represent about 0.2 percent of the flow of the primary source during construction and 1.6 percent and 0.8 percent during operation for the Large and Small ALWRs, respectively. Approximately 28 and 16 MGY of additional nonhazardous and/or sanitary wastewater generated during construction and 103 and 63 MGY during operation would be discharged to surface waters for the Large and Small ALWRs, respectively. Blowdown discharges to surface waters would be approximately 6,192 and 2,808 MGY, which could increase the flow of the receiving waters by 19.6 and 8.9 percent for the Large and Small ALWRs, respectively. Blowdown discharges are not expected to impact permitted water quality discharge levels. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation for either the Large or Small ALWR. Approximately 28 MGY of nonhazardous and/or sanitary wastewater generated during construction and 95 MGY during operation for the Large ALWR, and approximately 16 MGY and 55 MGY and for the Small ALWR would be discharged to playas. These represent increases of approximately 15 percent, 52 percent, 9 percent, and 30 percent, respectively. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Tritium Supply and Upgraded Recycling**—No surface water would be withdrawn during construction, but use would increase by approximately 15,530 MGY and 7,130 MGY during operation of the Large ALWR and Small ALWR, respectively. This represents approximately 78 percent and 36 percent increase in use and 3 percent in the flow of the primary source. Approximately 28 and 16 MGY of nonhazardous and sanitary wastewater is generated during construction for the Large and Small ALWR and 105 MGY during operation for the Large ALWR and 65 MGY for the Small ALWR would be discharged to surface waters. These represent increases of approximately 2 percent, 1 percent, 8 percent and 5 percent in stream flow. Blowdown discharges to surface waters would be approximately 6,192 MGY and 2,808 MGY, which could increase the flow of the receiving waters by 16,537 and 7,472 percent, respectively. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |

**Water Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor (Continued)** | • Groundwater use would increase by approximately 35 MGY (2 percent) during construction and by 104 MGY (5 percent) during operation for the Large ALWR and 22 MGY (1 percent) during construction and 64 MGY (3 percent) for the Small ALWR. Total groundwater use would represent about 18 percent of the groundwater allotment during construction and operation of the groundwater allotment for the Large and Small ALWRs, respectively. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected with either ALWR. | • Groundwater use would increase by approximately 35 MGY (6 percent) during construction and by 104 MGY (14 percent) during operation for the Large ALWR and 22 MGY (3 percent) during construction and 64 MGY (8 percent) for the Small ALWR. Withdrawals during operation would not exceed the lowest estimated aquifer recharge rate. There would be no discharges to groundwater, and impacts to groundwater quality would be not expected with either ALWR. |
| | • There would be no impacts associated with floodplains. | • There are no designated floodplains at NTS, however, a 500-year floodplain assessment would be required. |
| | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |

## Water Resources

| ORR | Pantex | SRS |
|---|---|---|
| • No groundwater would be used during construction or operation for either the Large or Small ALWRs. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. | • Groundwater use would increase by approximately 35 MGY (12 percent) during construction and by 104 MGY (31 percent) during operation for the Large ALWR and by 22 MGY (8 percent) during construction and 64 MGY (17 percent) during operation for the Small ALWR. Drawdowns during operation could affect aquifer water levels. There would be no direct discharges to groundwater, but treated wastewater discharged to playas could percolate into the groundwater. | • Groundwater use would increase by 33 MGY (1 percent) during construction and by 111 MGY (3 percent) during operation for the Large ALWR and 20 MGY (1 percent) and 71 MGY (3 percent) for the Small ALWR. Drawdown impacts are not expected. There would be no discharges to groundwater, and impacts to groundwater quality are not expected. |
| • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. |
| • **Tritium Supply Alone**—Total surface water requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharges to surface water would decrease by 0.9 MGY. | • **Tritium Supply Alone**—Total groundwater requirement would decrease 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharge to playas would decrease 0.9 MGY during construction and 4.5 MGY during operation. | • **No tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as the above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Surface water use would increase by approximately 10 MGY (<1 percent) during construction for the Phased and Full APT and by 1,705 MGY (92 percent) and by 2,656 MGY (145 percent) during operation, respectively. Total site surface water use would represent 0.2 percent during construction and 0.3 percent and 0.4 percent of the flow of the primary source during operation for the Phased and Full APT, respectively. Approximately 1 MGY of additional nonhazardous and/or sanitary wastewater generated during construction and 20 MGY during operation would be discharged to surface waters, respectively. | • **Collocated Tritium Supply and Recycling**—No surface water would be used during construction or operation, and there would be no discharges to surface water. However, 1 MGY of nonhazardous and/or sanitary wastewater generated during construction would be discharged to playas. This represents an increase of <1 percent. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | • **Tritium Supply and Upgrade Recycling**—No surface water would be used during construction, but use would increase by approximately 1,714 MGY and 2,665 MGY during operation for the Phased and Full APT. This represents approximately a 9 percent and 13 percent increase in use and 2 percent of the flow of the primary source. Approximately 0.3 MGY of additional nonhazardous and sanitary wastewater generated during construction for both the Phased and Full APT and 22 MGY during operation would be discharged to surface waters. The 22 MGY represents an increase of 2 percent change in stream flow. |

**Water Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium (Continued)** | | |
| | • Groundwater use would increase by approximately 10 MGY (<1percent) during construction for the Phased and Full APT and by 1,705 MGY (85 percent) and by 2,656 MGY (132 percent) during operation respectively. Total groundwater use would represent 18 percent of the groundwater allotment during construction for both the Phased and Full APT and 32 percent and 41 percent during operation, respectively. There would be no discharges to groundwater, and impacts to groundwater quality would not be expected. | • Groundwater use would increase by approximately 10 MGY (2 percent) during construction for the Phased and Full APT and by 1,705 MGY (267 percent) and 2,656 MGY (417 percent) during operation, respectively. Withdrawals during operation of Full APT exceed the lowest estimated recharge rate by 19 percent, but would not be expected to impact offsite springs. There would be no discharges to groundwater and impacts to groundwater quality would not be expected. |
| | • There would be no impacts associated with floodplains. | • There are no designated floodplains at NTS, however, a 500-year floodplain assessment would be required. |
| | • **Tritium Supply Alone**—Total groundwater requirement would decrease from collocated by 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. | • **Tritium Supply Alone**—Total groundwater requirement would decrease from collocated by 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. |
| **All Supply Technologies** | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling at INEL. The phaseout of recycling at SRS would decrease wastewater discharges to Three Runs Creek and Fourmile Branch by 0.3 percent and 3.2 percent and decrease groundwater withdraws by 134.5 MGY. The reduced wastewater discharge and reduced groundwater withdrawals would slightly decrease the potential impacts to water resources. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling at NTS. The phaseout of recycling at SRS would decrease wastewater discharges to Three Runs Creek and Fourmile Branch by 0.3 percent and 3.2 percent and decrease groundwater withdraws by 134.5 MGY. The reduced wastewater discharge and reduced groundwater withdrawals would slightly decrease the potential impacts to water resources. |

**Water Resources**

| ORR | Pantex | SRS |
|---|---|---|
| Blowdown discharges to surface waters would be approximately 288 and 528 MGY, which could increase the flow of the receiving waters by 0.9 and 1.7 percent. Blowdown discharges are not expected to impact permitted water quality discharge levels. Stormwater runoff would have negligible impacts on surface waters during construction and operation. | | Blowdown discharges to surface waters would be approximately 288 MGY and 528 MGY, which could increase the flow of the receiving waters by 788 percent or 1,409 percent. Stormwater runoff would have negligible impacts on surface waters during construction and operation. |
| • No groundwater would be used during construction or operation. There would be no discharges to groundwater, and no impacts to groundwater quality would be expected. | • Groundwater use would increase by 10 MGY (3 percent) during construction for the Phased and Full APT and by 1,705 MGY (591 percent) and 2,656 MGY (924 percent) during operation, respectively. Drawdowns during operation could affect aquifer water levels. There would be no direct discharges to groundwater, but treated wastewater discharged to playas could percolate into the groundwater. | • Groundwater use would increase by 8 MGY (0.3 percent) during construction and by 28 MGY (2 percent) during operation for the Phased and Full APT. Drawdown impacts are not expected. There would be no discharges to groundwater, and impacts to groundwater quality are not expected. |
| • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. | • No construction will take place in areas designated as 100-year floodplains, however, a 500-year floodplain assessment would be required. |
| • **Tritium Supply Alone**—Total surface water requirement would decrease from collocated 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharges to surface water would decrease by 0.9 MGY. | • **Tritium Supply Alone**—Total groundwater requirement would decrease from collocated 1.5 MGY during construction and 14 MGY during operation, therefore the potential impacts to water resources would be slightly reduced. Wastewater discharge to Playas would decrease 0.9 MGY during construction and 4.5 MGY during operation. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling at ORR. The phaseout of recycling at SRS would decrease wastewater discharges to Three Runs Creek and Fourmile Branch by 0.3 percent and 3.2 percent and decrease groundwater withdraws by 134.5 MGY. The reduced wastewater discharge and reduced groundwater withdrawals would slightly decrease the potential impacts to water resources. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling at Pantex. The phaseout of recycling at SRS would decrease wastewater discharges to Three Runs Creek and Fourmile Branch by 0.3 percent and 3.2 percent and decrease groundwater withdraws by 134.5 MGY. The reduced wastewater discharge and reduced groundwater withdrawals would slightly decrease the potential impacts to water resources. | • **No Tritium Supply Recycling Phaseout with SRS Alternatives.** |

**Geology and Soils**

| Technology | INEL | NTS |
|---|---|---|
| **No Action (2010)** | • No impacts to geology or soils. | • No impacts to geology or soils. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. |
| | • Soil conditions would not affect construction or operation. A total of 462 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 462 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. |
| | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions and the facilities would not be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions and the facilities would not be affected by geologic conditions. |
| | • Soil conditions would not affect construction or operation. A total of 562 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 562 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. |
| | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. |
| | • Soil conditions would not affect construction or operation. A total of 552 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 552 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. |

**Geology and Soils**

| ORR | Pantex | SRS |
|---|---|---|
| • No impacts to geology or soils. | • No impacts to geology or soils. | • No impacts to geology or soils. |
| • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. |
| • Soil conditions would not affect construction or operation. A total of 462 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 462 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 260 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would not affect geologic conditions, nor would the facilities be affected by geologic conditions. |
| • Soil conditions would not affect construction or operation. A total of 562 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 562 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 387 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. |
| • Soil conditions would not affect construction or operation. A total of 552 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 552 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 350 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. Phase out of recycling facilities would result in no impacts. |
| • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **No Tritium Supply Alone.** |

**Geology and Soils**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor (Continued)** | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. |
| | • Soil conditions would not affect construction or operation. A total of 375 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 375 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. |
| | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would not impact geology or soils. | • **Tritium Recycling Phaseout**— This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would not impact geology or soils. |
| **Biotic Resources** | | |
| **No Action (2010)** | • No impacts to biotic resources. | • No impacts to biotic resources. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 462 acres of habitat during construction and operation. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 462 acres of habitat during construction and operation. |
| | • Wetlands would not be affected by construction or operation. | • Wetlands would not be affected by construction or operation. |
| | • Aquatic resources would not be affected by construction or operation. | • Aquatic resources would not be affected by construction or operation. |

## Geology and Soils

| ORR | Pantex | SRS |
|---|---|---|
| • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. | • **Collocated Tritium Supply and Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. | • **Tritium Supply and Upgraded Recycling**—Construction and operation would not affect geologic conditions nor would the facilities be affected by geologic conditions. |
| • Soil conditions would not affect construction or operation. A total of 375 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 375 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. | • Soil conditions would not affect construction or operation. A total of 173 acres would be disturbed. Erosion may occur as a result of stormwater runoff and wind action. |
| • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **Tritium Supply Alone**—Construction and operation impacts to geology and soils would be the same as above. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would not impact geology or soils. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would not impact geology or soils. | • **No Tritium Recycling Phaseout with SRS Alternatives.** |
| **Biotic Resources** | | |
| • No impacts to biotic resources. | • No impacts to biotic resources. | • No impacts to biotic resources. |
| • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 462 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 462 acres of habitat during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Terrestrial resources would be affected by the disturbance of 260 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. |
| • If cooling tower blowdown is directed to East Fork Popular Creek, changes in water levels and sedimentation could effect wetlands associated with the stream. If directed to the Clinch River impacts would be limited to wetlands (if present) in the vicinity of the outfall. | • Depending on the final site layout, some small areas of potential wetlands could be impacted; mitigation measures approved by the U.S. Army Corps of Engineers would be implemented. During construction and operation impacts to playas could include increase in open water area and shift in wetland plant communities. | • If cooling tower blowdown is directed to Fourmile Branch, changes in flows and sedimentation could affect wetlands associated with the stream and Savannah River Swamp. Impacts to wetlands would be avoided if discharges are directed to Par Pond. |
| • If cooling tower blowdown is directed to East Fork Popular Creek, increase in flow, sedimentation and temperature could impact aquatic communities. Impacts to aquatic communities would be reduced if discharges are directed to the Clinch River. | • Aquatic resources would not be affected by construction or operation. Some temporary aquatic habitat may be created by discharges of nonhazardous wastewater to playas. | • If cooling tower blowdown is directed to Fourmile Branch, increases in flow, sedimentation, and temperature could impacts aquatic communities. Impacts to aquatic communities would be reduced if discharges are directed to Par Pond. |

**Biotic Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidate or state-listed species may be affected. During construction, the ferruginous hawk, loggerhead shrike and pygmy rabbit would lose 462 acres of potential foraging and nesting or burrowing habitat; the Townsend's western big-eared bat may roost in caves and forage throughout the disturbed area; and the plant species oxytheca may be affected. During operation, the Townsend's western big-eared bat may forage at stormwater retention ponds. | • One Federal-listed threatened species, the desert tortoise, could be affected during construction and operation. Several Federal candidate or state-listed species may be affected. The ferruginous hawk could lose 462 acres of foraging habitat; while the loggerhead shrike could lose the same acreage of foraging and breeding habitat. Neither species should be adversely affected due to the large extent of nearby suitable habitat. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Tritium Supply Alone**—Construction and operation would disturb 260 acres; thus, impacts to biotic resources would be slightly reduced.<br>• **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling.<br>• **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 562 acres of habitat during construction and operation.<br>• Wetlands would not be affected by construction or operation.<br>• Aquatic resources would not be affected by construction or operation. | • **Tritium Supply Alone**—Construction and operation would disturb 260 acres; thus, impacts to biotic resources would be slightly reduced.<br>• **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling.<br>• **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 562 acres of habitat during construction and operation.<br>• Wetlands would not be affected by construction or operation.<br>• Aquatic resources would not be affected by construction or operation. |

**Biotic Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No Federal-listed, threatened, or endangered species would be affected during construction or operation. Land clearing activities may impact several state-protected plant species. Four state-listed raptors would lose 462 acres of potential nesting and foraging habitat, however, this type of habitat is abundant in the area. The Tennessee dace and hellbender, both state-listed, could be affected by construction and operation, respectively. | • One Federal-listed, threatened species, the bald eagle, could be affected by disrupting foraging at playas during construction. Six Federal candidate or state-listed species may also be affected by construction activities. The black tern, white-faced ibis, ferruginous hawk and loggerhead shrike could lose 462 acres of foraging and/or nesting habitat. The swift fox would lose potential foraging and denning habitat. The Texas horned lizard could be impacted during land clearing activities. | • No Federal-listed, threatened, or endangered species would be affected during construction or operation. Several Federal candidate or state-listed species may be impacted during construction. These include the awned meadow-beauty, green-fringed orchid, Florida false loosestrife, beak-rush, star-nosed mole, and eastern tiger salamander. All of these could be destroyed during construction. In addition, the Cooper's hawk could be temporarily displaced during construction. |
| • **Tritium Supply Alone**—Construction and operation would disturb 260 acres, thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 260 acres, thus, impacts to biotic resources would be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts to biotic resource are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 562 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 562 acres of habitat during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Terrestrial resources would be affected by the disturbance of 360 acres of habitat during construction operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. |
| • Increased stream flow in East Fork Popular Creek from construction dewatering discharge could alter wetlands bordering the stream. Cooling tower blowdown could also adversely affect wetlands during operation. If discharges are directed to the Clinch River impacts would be confined to wetlands (if present) near the outfall. | • Depending on the final site layout, some small areas of potential wetlands could be impacted; mitigation measures approved by the U.S. Army Corps of Engineers would be implemented. During construction and operation impacts to playa could include increases in open water area and shifts in wetland plant communities. | • Increased stream flow in Fourmile Branch from construction dewatering discharge could alter wetlands bordering the stream and within the Savannah River Swamp. Cooling tower blowdown could also adversely affect these wetlands during operation if discharged to Fourmile Branch. Impacts could be avoided if discharges are directed to Par Pond. |
| • If dewatering discharges from construction were directed to East Fork Popular Creek increased flows and sedimentation could adversely affect aquatic communities. Cooling tower blowdown could also displace aquatic communities if directed to the creek. Impacts to aquatic resources could be reduced if discharges are directed to the Clinch River. | • Aquatic resources would not be affected by construction or operation. Some temporary aquatic habitat may be created by discharges of nonhazardous wastewater to playas. | • If dewatering discharges from construction were directed to Fourmile Branch increased flows and sedimentation could adversely impact aquatic communities. Cooling tower blowdown could also displace aquatic communities if directed for Fourmile Branch. Impacts to aquatic communities could be reduced if discharges are directed to Par Pond. |

**Biotic Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidate or state-listed species may be affected. During construction, the ferruginous hawk, loggerhead shrike, and pygmy rabbit would lose 562 acres of potential foraging and nesting or burrowing habitat; the Townsend's western big-eared bat may roost in caves and forage throughout the disturbed area; and the plant species oxytheca may be present. During operation, the Townsend's western big-eared bat may forage at stormwater retention ponds. | • One Federal-listed threatened species, the desert tortoise, could be affected during construction and operation. Several Federal candidate or state-listed species may be affected. The ferruginous hawk could lose 562 acres of foraging habitat; while the loggerhead shrike could lose the same acreage of foraging and breeding habitat. However, neither species should be adversely affected due to the large extent of nearby suitable habitat. |
| | • **Tritium Supply Alone**—Construction and operation would disturb 360 acres; thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 360 acres; thus, impacts to biotic resources would be slightly reduced. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 552 acres of habitat during construction and operation. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 552 acres of habitat during construction and operation. |
| | • Wetlands would not be affected by construction or operation. | • Wetlands would not be affected by construction or operation. |
| | • Aquatic resources would not be affected by construction or operation. | • Aquatic resources would not be affected by construction or operation. |

**Biotic Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No Federal-listed, threatened, or endangered species would be affected during construction or operation. Land clearing activities may impact several state-protected plant species. Four state-listed raptors would lose 562 acres of potential nesting and foraging habitat, however, this type of habitat is abundant in the area. The Tennessee dace and hellbender, both state-listed, could be affected by construction and operation, respectively. | • One Federal-listed threatened species, the bald eagle, could be affected by disrupting foraging at playas during construction. Six Federal candidate or state-listed species may also be affected by construction activities. The black tern, white-faced ibis, ferruginous hawk, and the loggerhead shrike could lose 562 acres of foraging and/or nesting habitat. The swift fox would lose potential foraging and denning habitat. Texas horned lizards would be impacted during land clearing activities. | • No Federal-listed, threatened or endangered species would be affected during construction or operation. Several Federal candidate or state-listed species may be impacted during construction. These include the awned meadow-beauty, green-fringed orchid, Florida false loosestrife, beak-rush, star-nosed mole, and eastern tiger salamander. All of these could be destroyed during construction. In addition, the Cooper's hawk could be temporarily displaced during construction. |
| • **Tritium Supply Alone**—Construction and operation would disturb 360 acres; thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 360 acres; thus, impacts to biotic resources would be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts to biotic resource are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 552 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 552 acres of habitat during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Terrestrial resources would be affected by the disturbance of 350 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. |
| • If cooling tower blowdown is directed to East Fork Poplar Creek, changes in water levels and sedimentation could affect wetlands associated with the stream. If directed to the Clinch River, impacts would be limited to wetlands (if present) in the vicinity of the outfall. | • Depending on the final site layout, some small areas of potential wetlands could be impacted; mitigation measures approved by the U.S. Army Corps of Engineers would be implemented. During construction and operation impacts to playas could include increases in open water areas and shifts in wetland plant communities. | • If cooling tower blowdown is directed to Fourmile Branch, changes in flows and sedimentation could affect wetlands associated with the stream and Savannah River Swamp. Impacts to wetlands would be avoided if discharges are directed Par Pond. |
| • If cooling tower blowdown is directed to East Fork Poplar Creek, increase in flow, sedimentation and temperature could impact aquatic communities. Impacts to aquatic communities would be reduced if discharges are directed to the Clinch River. | • Aquatic resources would not be affected by construction or operation. Some temporary aquatic habitat may be created by discharges of nonhazardous wastewater to playas. | • If cooling tower blowdown is directed to Fourmile Branch, increases in flow, sedimentation, and temperature could impact aquatic communities. Impacts to aquatic communities would be reduced if discharges are directed to Par Pond. |

**Biotic Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor (Continued)** | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidate or state-listed species may be affected. During construction, the ferruginous hawk would lose 552 acres of potential foraging and nesting or burrowing habitat; the Townsend's western big-eared bat may roost in caves and forage throughout the disturbed area; and the plant species oxytheca may be affected. During operation, the Townsend's western big-eared bat may forage at stormwater retention ponds. | • One Federal-listed threatened species, the desert tortoise, could be affected during construction and operation. Several Federal candidate or state-listed species may be affected. The ferruginous hawk could lose 552 acres of foraging habitat; while the loggerhead shrike could lose the same acreage of foraging and breeding habitat. However, neither species should be adversely affected due to the large extent of nearby suitable habitat. |
| | • **Tritium Supply Alone**—Construction and operation would disturb 350 acres; thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 350 acres; thus, impacts to biotic resources would be slightly reduced. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 375 acres of habitat during construction and operation. Impacts from salt drift are possible with the APT. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 375 acres of habitat during construction and operation. Impacts from salt drift are possible with the APT. |
| | • Wetlands would not be affected by construction or operation. | • Wetlands would not be affected by construction or operation. |
| | • Aquatic resources would not be affected by construction or operation. | • Aquatic resources would not be affected by construction or operation. |

**Biotic Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No Federal-listed, threatened, or endangered species to be affected during construction or operation. Land clearing activities may impact several state-protected plant species. Four state-listed raptors would lose 552 acres of potential nesting and foraging habitat, however, this type of habitat is abundant in the area. The Tennessee dace and hellbender, both state-listed, could be affected by construction and operation, respectively. | • One Federal-listed threatened species, the bald eagle, could be affected by disrupting foraging in playas during construction. Six Federal candidate or state-listed species may also be affected by construction activities. The black tern, bald eagle, white-faced ibis, ferruginous hawk, and loggerhead shrike could lose 552 acres of foraging and/or nesting habitat. The swift fox would lose potential foraging and denning habitat. The Texas horned lizards could be impacted during land clearing activities. | • No Federal-listed, threatened, or endangered species would be affected during construction or operation. Several Federal candidate or state-listed species may be impacted during construction. These include the awned meadow-beauty, green-fringed orchid, Florida false loosestrife, beak-rush, star-nosed mole, and eastern tiger salamander. All of these could be destroyed during construction. In addition, the Cooper's hawk could be temporarily displaced during construction. |
| • **Tritium Supply Alone**—Construction and operation would disturb 350 acres; thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 350 acres; thus, impacts to biotic resources would be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts to biotic resource are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 375 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. | • **Collocated Tritium Supply and Recycling**—Terrestrial resources would be affected by the disturbance of 375 acres of habitat during construction and operation. Impacts from salt drift are possible with the APT. | • **Tritium Supply and Upgraded Recycling**—Terrestrial resources would be affected by the disturbance of 173 acres of habitat during construction and operation. Salt drift from wet cooling towers would likely impact less than 13 acres during operation. |
| • Increased stream flow in East Fork Poplar Creek from construction dewatering discharge associated with an APT could alter wetlands bordering the stream. Cooling tower blowdown could also adversely effect these wetlands during operation. If these discharges are directed to Clinch River impacts would be confined to wetlands (if present) near the outfall. | • Depending on the final site layout, some small areas of potential wetlands could be impacted; mitigation measures approved by the U.S. Army Corps of Engineers would be implemented. During construction and operation, impacts to playa wetlands could include increases in open water area and shifts in wetland plant communities. | • Increased stream flow in Fourmile Branch from construction dewatering discharge associated with an APT could alter wetlands bordering the stream and within the Savannah River Swamp. Cooling tower blowdown could also adversely effect these wetlands during operation if discharged to Fourmile Branch. Impacts could be avoided if discharges are directed to Par Pond. |
| • If dewatering discharges from construction of an APT were directed to East Fork Poplar Creek, increased flows and sedimentation could adversely affect aquatic communities. Cooling tower blowdown could also displace aquatics communities if directed to the creek. Impacts to aquatic resources could be reduced if discharges are directed to the Clinch River. | • Aquatic resources would not be affected by construction or operation. Some temporary aquatic habitat may be created by discharges of nonhazardous wastewater to playas. | • If dewatering discharges from construction of an APT were directed to Fourmile Branch, increased flows and sedimentation could adversely impact aquatic communities. Cooling tower blowdown could also displace aquatic communities if directed to Fourmile Branch. Impacts to aquatic communities could be reduced if discharges are directed to Par Pond. |

**Biotic Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium (Continued)** | • No Federal-listed threatened and endangered species would be affected during construction or operation, but several Federal candidate or state-listed species may be affected. During construction, the ferruginous hawk, loggerhead shrike, and pygmy rabbit would lose 375 acres of foraging and nesting or burrowing habitat; the Townsend's western big-eared bat may roost in caves and forage throughout the disturbed area; and the plant species oxytheca may be affected. During operation, the Townsend's western big-eared bat may forage at stormwater retention ponds. | • One Federal-listed threatened species, the desert tortoise, could be affected during construction and operation. Several Federal candidate or state-listed species may be affected. The ferruginous hawk could lose 375 acres of foraging habitat; while the loggerhead shrike could lose the same acreage of foraging and breeding habitat. However, neither species should be adversely affected due to the large extent of nearby suitable habitat. |
| | • **Tritium Supply Alone**—Construction and operation would disturb 173 acres; thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 173 acres; thus, impacts to biotic resources would be slightly reduced. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**— This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would not impact biotic resources at the site. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would not impact biotic resources at the site. |
| **Cultural and Paleontological Resources** | | |
| **No Action (2010)** | • No impacts to cultural and paleontological resources. | • No impacts to cultural and paleontological resources. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. |
| | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| | • Paleontological resources would not be affected. | • Paleontological resources may be affected. |
| | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. |
| | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. |

**Biotic Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • No Federal-listed, threatened, or endangered species would be affected during construction or operation. Land clearing activities may impact of several state-protected plant species. Four state-listed raptors would lose 375 acres of potential nesting and foraging habitat, however, this type of habitat is abundant in the area. The Tennessee dace and hellbender, both state-listed, could be affected by construction and operation, respectively. | • One Federal-listed threatened species, the bald eagle, could be affected by disrupting foraging in playas during construction. Six Federal candidate or state-listed species may also be affected by construction activities. The black tern, white-faced ibis, ferruginous hawk, and loggerhead shrike would lose 375 acres of foraging and/or nesting habitat. The swift fox would lose potential foraging and denning habitat. The Texas horned lizard could be impacted during land clearing activities. | • No Federal-listed threatened or endangered species would be affected during construction or operation. Several Federal candidate or state-listed species may be impacted during construction. These include the awned meadow-beauty, green-fringed orchid, Florida false loosestrife, beak-rush, star-nosed mole, and eastern tiger salamander. All of these could be destroyed during construction. In addition, the Cooper's hawk could be temporarily displaced during construction. |
| • **Tritium Supply Alone**—Construction and operation would disturb 173 acres; thus, impacts to biotic resources would be slightly reduced. | • **Tritium Supply Alone**—Construction and operation would disturb 173 acres; thus impacts to biotic resources would be slightly reduced. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts to biotic resource are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would not impact biotic resources at the site. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would not impact biotic resources at the site. | • **No Tritium Recycling Phaseout With SRS Alternatives.** |
| **Cultural and Paleontological Resources** | | |
| • No impacts to cultural and paleontological resources. | • No impacts to cultural and paleontological resources. | • No impacts to cultural and paleontological resources. |
| • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Tritium Supply and Upgraded Recycling**—Three NRHP-eligible historic sites occur within the disturbed area. No prehistoric resources would be affected. |
| • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| • Paleontological resources may be affected. | • Paleontological resources may be affected. | • Paleontological resources may be affected. |
| • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the tritium supply and recycling facility. |

**Cultural and Paleontological Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. |
| | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| | • Paleontological resources may be affected by excavations deeper than 50 feet. | • Paleontological resources may be affected. |
| | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. |
| | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. |
| | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| | • Paleontological resources would not be affected. | • Paleontological resources may be affected. |
| | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. |
| | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. |

**Cultural and Paleontological Resources**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Tritium Supply and Upgraded Recycling**—Three NRHP-eligible historic sites occur within the disturbed area. No prehistoric resources would be affected. |
| • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| • Paleontological resources may be affected, but impacts would be negligible. | • Paleontological resources may be affected. | • Paleontological resources may be affected, but impacts would be negligible. |
| • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operation**—Impacts to prehistoric/historic resources and Native American resources are expected to be the same as above for the collocated supply and recycling. Impacts to Paleontological resources may be slightly smaller. | • **Less Than Baseline Operation**—Impacts to prehistoric/historic resources and Native American resources are expected to be the same as above for the collocated supply and recycling. Impacts to Paleontological resources may be slightly smaller. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Tritium Supply and Upgraded Recycling**—Three NRHP-eligible historic sites occur within the disturbed area. No prehistoric resources would be affected. |
| • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| • Paleontological resources may be affected, but impacts would be negligible. | • Paleontological resources may be affected. | • Paleontological resources may be affected, but impacts would be negligible. |
| • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |

**Cultural and Paleontological Resources**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. |
| | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| | • Paleontological resources may be affected by excavations deeper than 50 feet. | • Paleontological resources may be affected. |
| | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. |
| | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would not impact cultural or paleontological resources. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would not impact cultural or paleontological resources. |
| **Socioeconomics** | | |
| **No Action (2010)** | • Between 1990 and 1994, employment at INEL decreased by 1,000 persons to 10,100, and will remain at this level through 2020. The total INEL payroll was $436 million in 1994 and is expected to remain at this level through 2010. | • Between 1990 and 1994, employment at NTS decreased by 1,170 persons to 6,850, and will remain at this level through 2020. The total INEL payroll was $355 million in 1994 and is expected to remain at this level through 2010. |
| | • Employment in the economic study area is expected to grow by less than 1 percent annually through 2010 and then decrease annually by less than 1 percent through 2020. Unemployment is expected to remain at 6.4 percent between 2001 and 2020, and per capita income is expected to increase from $17,800 to $20,900. | • Employment in the economic study area is expected to grow by 1 percent annually through 2009 and then to continue growth at less than 1 percent annually through 2020. Unemployment is expected to remain at 5 percent between 1999 and 2020, and per capita income is expected to increase from $23,600 to $25,100. |

## Cultural and Paleontological Resources

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Collocated Tritium Supply and Recycling**—Some NRHP-eligible prehistoric and historic resources are expected to occur within the disturbed area. | • **Tritium Supply and Upgraded Recycling**—Three NRHP-eligible historic sites occur within the disturbed area. No prehistoric resources would be affected. |
| • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. | • Native American resources may be affected by land disturbance and audio or visual intrusions. |
| • Paleontological resources may be affected, but impacts would be negligible. | • Paleontological resources may be affected. | • Paleontological resources may be affected, but impacts would be negligible. |
| • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **Tritium Supply Alone**—Construction and operation impacts to cultural and paleontological would be slightly reduced, due to a smaller amount of land being disturbed. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operation**—Impacts to prehistoric/historic resources and Native American resources are expected to be the same as above for the collocated supply and recycling. Impacts to Paleontological resources may be slightly smaller. | • **Less Than Baseline Operation**—Impacts to prehistoric/historic resources and Native American resources are expected to be the same as above for the collocated supply and recycling. Impacts to Paleontological resources may be slightly smaller. | • **Less Than Baseline Operation**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facility. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would not impact cultural or paleontological resources. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would not impact cultural or paleontological resources. | • **No Tritium Recycling Phaseout With SRS Alternatives.** |
| **Socioeconomics** | | |
| • Between 1990 and 1994, employment at ORR decreased by 300 persons to 15,000, and will remain at this level through 2020. The total INEL payroll was $513 million in 1994 and is expected to remain at this level through 2010. | • Between 1990 and 1994, employment at Pantex decreased by 1,000 persons to 3,400. It will decrease to 1,790 in 2010 and is expected to remain at this level through 2020. The total Pantex payroll was $174 million in 1994 and is expected to decrease to $85 million in 2010. | • Between 1990 and 1994, employment at SRS decreased by 2,000 persons to 20,300. It will decrease to 16,900 in 2010 and is expected to remain at this level through 2020. The total Pantex payroll was $1.22 million in 1994 and is expected to reach $1.25 million in 2010. |
| • Employment in the economic study area is expected to grow by 1 percent annually through 2009 and then grow at less than 1 percent annually through 2020. Unemployment is expected to remain at 6.2 percent between 2001 and 2020, and per capita income is expected to increase from $17,900 to $20,700. | • Employment in the economic study area is expected to grow by less than 1 percent annually between 2001 and 2009, with less than 1 percent growth annually through 2020. Unemployment is expected to remain at 4.6 percent between 2001 and 2020, and per capita income is expected to increase from $22,300 to $25,700. | • Employment in the economic study area is expected to grow by less than 1 percent annually between 2001 and 2020. Unemployment is expected to remain at 4.8 percent between 2001 and 2020, and per capita income is expected to increase from $18,300 to $21,000. |

**Socioeconomics**

| Technology | INEL | NTS |
|---|---|---|
| **No Action (2010) (Continued)** | • Population and housing annual average increases are expected to be less than 1 percent through 2010. Population in the region-of-influence is expected to reach 207,300 in 2010 and 215,200 in 2020. Total housing units in the region-of-influence are expected to reach 75,400 in 2010 and 78,300 in 2020. | • Population and housing annual average increases are expected to be 1 percent through 2020. Population in the region-of-influence is expected to reach 1,020,900 in 2010 and 1,103,500 in 2020. Total housing units in the region-of-influence are expected to reach 437,400 in 2010 and 472,800 in 2020. |
| | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent from 2001 to 2020. | • Total revenues and expenditures for all region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent to 4 percent between 2001 and 2005, and by 1 to 2 percent between 2005 and 2010. Between 2010 and 2020 total revenues and expenditures are expected to increase by annual averages of 1 percent or less. |
| | • Any increase in traffic would not be a result of DOE activities. | • Any increase in traffic would not be a result of DOE activities. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 7,500 persons during peak construction and by 4,900 persons during full operation. Unemployment is expected to decrease to 4.5 percent during peak construction and then increase to 4.6 percent during full operation. Per capita income is expected to increase by an annual averages of 1 to 2 percent during construction and 2 percent during operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 9,500 persons during peak construction and by 5,500 persons during full operation. Unemployment is expected to decrease to 3.9 percent during peak construction and then increase to 4.3 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. |
| | • Population and housing demand in the region-of-influence would not increase by more than 5 percent over No Action during construction, and would increase not by more than 2 percent during operation. Population in the region-of-influence is expected to reach 211,400 in 2010. Total housing units in the region-of-influence are expected to reach 77,000 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 1,024,900 in 2010. Total housing units in the region-of-influence are expected to reach 438,000 in 2010. |
| | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase between 2 and less than 1 percent between 2002 and 2005 and then remain flat until 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for all region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent to 3 percent between 2001 and 2005, and then increase by about 1 percent by 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. |

**Socioeconomics**

| ORR | Pantex | SRS |
|---|---|---|
| • Population and housing annual average increases are expected to be 1 percent through 2009 and less than 1 percent between 2010 and 2020. Population in the region-of-influence is expected to reach 561,000 in 2010 and 586,000 in 2020. Total housing units in the region-of-influence are expected to reach 239,800 in 2010 and 250,500 in 2020. | • Population and housing annual average increases are expected to be less than 1 percent through 2020. Population in the region-of-influence is expected to reach 205,100 in 2010 and 209,000 in 2020. Total housing units in the region-of-influence are expected to reach 88,400 in 2010 and 90,000 in 2020. | • Population and housing annual average increases are expected to be less than 1 percent through 2010. Population in the region-of-influence is expected to reach 454,900 in 2010 and 473,000 in 2020. Total housing units in the region-of-influence are expected to reach 181,400 in 2010 and 188,000 in 2020. |
| • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of approximately 1 percent or less through 2010 and 2020. | • Total revenues and expenditures for all region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent through 2020. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent through 2020. |
| • Any increase in traffic would not be a result of DOE activities. | • Any increase in traffic would not be a result of DOE activities. | • Any increase in traffic would not be a result of DOE activities. |
| • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 8,300 persons during peak construction and by 5,200 persons during peak operation. Unemployment is expected to decrease to 5.2 percent during peak construction and then increase to 5.6 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 7,600 persons during peak construction and by 5,300 persons during full operation. Unemployment is expected to decrease to 2.2 percent during peak construction and then increase to 2.5 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Employment in the economic study area is expected to increase by 7,200 persons during peak construction and by 2,400 persons during peak operation. Unemployment is expected to decrease to 3.9 percent during peak construction and then increase to 4.5 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. |
| • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 563,500 in 2010. Total housing units in the region-of-influence are expected to reach 240,700 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 4 percent over No Action during construction and not increase by more than 2 percent during operation. Population in the region-of-influence is expected to reach 208,500 in 2010. Total housing units in the region-of-influence are expected to reach 89,600 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 456,100 in 2010. Total housing units in the region-of-influence are expected to reach 181,800 in 2010. |
| • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of approximately 1 percent or less through 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase 1 percent annually to 2005, and then remain flat until 2010. Between 2010 and 2020 total revenues and expenditures are expected to increase at annual averages of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase on an annual average of less than 1 percent until 2010. |

**Socioeconomics**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, U.S. Route 20/26. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Mercury Highway. |
| | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. |
| | • Population and housing demands in the region-of-influence would not increase by more than 4 percent over No Action during construction, and would not increase by more than 1 percent during operation. | • Population and housing demands in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. |
| | • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | • Total revenues and expenditures would be increased for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. |
| | • The effects on traffic on site access routes would be slightly less than collocation with recycling. | • The effects on traffic on site access routes would be slightly less than collocation with recycling. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 7,200 persons during peak construction and by 4,900 persons during full operation. Unemployment is expected to decrease to 4.5 percent during peak construction and then increase to 4.6 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 9,100 persons during peak construction and by 5,500 persons during full operation. Unemployment is expected to decrease to 3.9 percent during peak construction and then increase to 4.3 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. |
| | • Population and housing demand in the region-of-influence would not increase by more than 5 percent over No Action during construction, and would not increase by more than 2 percent during operation. Population in the region-of-influence is expected to reach 211,300 in 2010. Total housing units in the region-of-influence are expected to reach 77,000 in 2010. | • Population and housing demand in the region-of-influence would increase by more than 1 percent over No Action during construction or operation. Population in the region-of-influence is expected to reach 1,024,900 in 2010. Total housing units in the region-of-influence are expected to reach 438,000 in 2010. |

**Socioeconomics**

| ORR | Pantex | SRS |
|---|---|---|
| • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Bear Creek Road. | • Traffic conditions would worsen slightly on site access roads, particulary on the primary areas site, Farm-to-Market Road 683. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, State Route 125. |
| • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **No Tritium Supply Alone.** |
| • Population and housing demands would not increase by no more than 1 percent over No Action during construction and operation. | • Population and housing demands would not increase by more than 3 percent over No Action during construction, and would not increase by more than 1 percent during operation. | |
| • Revenues and expenditures would be increased for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would be increased for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | |
| • The effects on traffic on site access routes would be slightly less than collocation with recycling. | • The effects on traffic on site access routes would be slightly less than collocation with recycling. | |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facilities |
| • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 8,000 persons during peak construction and by 5,100 persons during full operation. Unemployment is expected to decrease to 5.2 percent during peak construction and to increase to 5.6 during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 7,300 persons during peak construction and by 5,300 persons during full operation. Unemployment is expected to decrease to 2.2 percent during peak construction and increase to 2.5 percent during full operation. Per capita income is expected to increase by an annual average of less than 1 percent during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Employment in the economic study area is expected to increase by 6,900 persons during peak construction and by 2,300 persons during full operation. Unemployment is expected to decrease to 4.0 percent during peak construction and then increase to 4.6 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. |
| • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 563,400 in 2010. Total housing units in the region-of-influence are expected to reach 240,700 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 3 percent over No Action during construction, and would not increase by more than 2 percent during operation. Population in the region-of-influence is expected to reach 208,400 in 2010. Total housing units in the region-of-influence are expected to reach 89,600 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 456,000 in 2010. Total housing units in the region-of-influence are expected to reach 181,800 in 2010. |

**Socioeconomics**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase between 2 and less than 1 percent between 2002 and 2005 and then remain flat until 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for all region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent to 2 percent between 2001 and 2005, and then increase about 1 percent by 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. |
| | • Traffic conditions would degrade on site access roads, particularly on the primary access route, U.S. Route 20/26. | • Traffic conditions would degrade on site access roads, particularly on the primary access route, Mercury Highway. |
| | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. |
| | • Population and housing demands would increase by more than 4 percent over No Action during construction, and would not increase by more than 1 percent during operation. | • Population and housing demands would increase by more than 1 percent over No Action during construction and operation. |
| | • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. |
| | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. |
| | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the collocated supply and recycling except during operation when the impacts are expected to be reduced for employment, economics, revenues, and expenditures. | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the collocated supply and recycling except during operation when the impacts are expected to be reduced for employment, economics, revenues, and expenditures. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 10,800 persons during peak construction and by 4,700 persons during full operation for either ALWR. Unemployment is expected to decrease to 4.5 percent during peak construction and then increase to 4.7 during full operation. Per capita income is expected to increase by an annual average of almost 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 13,700 persons during peak construction and by 5,200 persons during full operation for either ALWR. Unemployment is expected to decrease to 3.9 percent during peak construction and then increase to 4.4 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. |

**Socioeconomics**

| ORR | Pantex | SRS |
|---|---|---|
| • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of approximately 1 percent or less through 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of 1 percent to 2005 and then remain flat until 2010. Between 2010 and 2020 total revenues and expenditures are expected to increase at annual averages of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent through 2020. |
| • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Bear Creek Road. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Farm-to-Market Road 683. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, State Route 125. |
| • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **No Tritium Supply Alone.** |
| • Population and housing demands would increase by no more than 1 percent over No Action during construction and operation. | • Population and housing demands would increase by more than 2 percent over No Action during construction, and would not increase more than 1 percent during operation. | |
| • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | |
| • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | |
| • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the collocated supply and recycling except during operation when the impacts are expected to be reduced for employment, economics, revenues, and expenditures. | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the collocated supply and recycling except during operation when the impacts are expected to be reduced for employment, economics, revenues, and expenditures. | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the tritium supply and upgraded recycling facility except during operation when the impacts are expected to be reduced for employment, economics, revenues, and expenditures. |
| • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 12,000 persons during peak construction and by 4,900 persons during full operation for either ALWR. Unemployment is expected to decrease to 4.8 percent during peak construction and then increase to 5.6 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 10,900 persons during peak construction and by 5,000 persons during full operation for either ALWR. Unemployment is expected to decrease to 2.2 percent during peak construction and the increase to 2.7 percent during full operation. Per-capita income is expected to increase by an annual average of less than 1 percent during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Employment in the economic study area is expected to increase by 10,800 persons during peak construction and by 2,100 persons during full operation for either ALWR. Unemployment is expected to decrease to 3.9 percent during peak construction and then increase to 4.6 percent during full operation. Per capita income is expected to increase by an annual average of just under 1 percent during construction and operation. |

**Socioeconomics**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor (Continued)** | • For either ALWR, population and housing demand in the region-of-influence would not increase by more than 9 percent during construction, and would not increase by more than 2 percent during operation. Population in the region-of-influence is expected to reach 211,100 in 2010. Total housing units in the region-of-influence are expected to reach 76,900 in 2010. | • For either ALWR, population and housing demand in the region-of-influence would not increase by more than 2 percent during construction, and would not increase by more than 1 percent during operation. Population in the region-of-influence is expected to reach 1,024,700 in 2010. Total housing units in the region-of-influence are expected to reach 437,900 in 2010. |
| | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase between 4 percent to less than 1 percent in the first 3 years of construction, then decrease 1 to 2 percent annually until 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for all region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent to 4 percent between 2001 and 2005, then increase about 1 percent by 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. |
| | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, U.S. Route 20/26. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Mercury Highway. |
| | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. |
| | • Population and housing demands would increase by more than 8 percent over No Action during construction, and would not increase by more than 1 percent during operation. | • Population and housing demands would increase by more than 2 percent over No Action during construction, and would not increase by more than 1 percent during operation. |
| | • Revenues and expenditures would increase for all region-of-influence counties, cities and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would increase for all region-of-influence counties, cities and school districts but these increases would be less than collocation with recycling. |
| | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. |
| | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. |

**Socioeconomics**

| ORR | Pantex | SRS |
|---|---|---|
| • For either ALWR, population and housing demand in the region-of-influence would not increase by more than 2 percent over No Action during construction, and would not increase by more than 1 percent during operation. Population in the region-of-influence is expected to reach 563,300 in 2010. Total housing units in the region-of-influence are expected to reach 240,700 in 2010. | • For either ALWR, population and housing demand in the region-of-influence would not increase by more than 7 percent over No Action during construction, and would not increase by more than 2 percent during operation. Population in the region-of-influence is expected to reach 208,200 in 2010. Total housing units in the region-of-influence are expected to reach 89,500 in 2010. | • For either ALWR, population and housing demand in the region-of-influence would not increase by more than 3 percent over No Action during construction, and would not increase by more than 1 percent during operation. Population in the region-of-influence is expected to reach 456,000 in 2010. Total housing units in the region-of-influence are expected to reach 181,800 in 2010. |
| • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of approximately 1 percent or less through 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of 1 percent to 2 percent to 2005, and then decrease by 1 percent until 2010. Between 2010 and 2020 total revenues and expenditures are expected increase at annual average of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent to 2 percent through 2005, and then remain flat to 2010. Between 2010 and 2020 total revenues and expenditures are expected to increase by annual averages of less than 1 percent. |
| • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Bear Creek Road. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route Farm-to-Market Road 683. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, South Carolina Route 125 |
| • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **No Tritium Supply Alone.** |
| • Population and housing demands would increase by no more than 1 percent over No Action during construction and operation. | • Population and housing demands would increase by more than 6 percent over No Action during construction, and would not increase by more than 1 percent during operation. | |
| • Revenues and expenditures would increase for all region-of-influence counties, cities and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would increase for all region-of-influence counties, cities and school districts but these increases would be less than collocation with recycling. | |
| • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | |
| • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the collocated supply and recycling. | • **Less Than Baseline Operations**—Impacts are expected to be the same as above for the tritium supply and upgraded recycling facilities. |

**Socioeconomics**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 4,800 persons during peak construction and by 4,100 persons during full operation. Unemployment is expected to decrease to 4.5 percent during peak construction and then increase to 4.9 percent during full operation. Per capita income is expected to increase by an annual average of almost 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 6,000 persons during peak construction and by 4,600 persons during full operation. Unemployment is expected to decrease to 4.0 percent during peak construction and then increase to 4.4 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. |
| | • Population and housing demand in the region-of-influence would not increase by more than 2 percent over No Action during construction or operation. Population in the region-of-influence is expected to reach 210,000 in 2010. Total housing units in the region-of-influence are expected to reach 76,500 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction or operation. Population in the region-of-influence is expected to reach 1,023,600 in 2010. Total housing units in the region-of-influence are expected to reach 438,600 in 2010. |
| | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of 1 percent or less through 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for all region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent to 2 percent between 2001 and 2005, and then increase 1 to 2 percent by 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by an annual average of less than 1 percent. |
| | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, U.S. Route 20/26. | • Traffic conditions would worsen slightly on site access roads, particularly on the primary access route, Mercury Highway. |
| | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. |
| | • Population and housing demands would increase by more than 1 percent over No Action during construction and operation. | • Population and housing demands would increase by more than 1 percent over No Action during construction and operation. |
| | • Revenues and expenditures would be reduced for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would be reduced for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. |
| | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. |

**Socioeconomics**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 5,300 persons during peak construction and by 4,300 persons during full operation. Unemployment is expected to decrease to 5.5 percent during peak construction and then increase to 5.7 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Collocated Tritium Supply and Recycling**—Employment in the economic study area is expected to increase by 4,800 persons during peak construction and by 4,400 persons during full operation. Unemployment is expected to decrease to 2.7 percent during peak construction and then increase to 2.8 percent during full operation. Per capita income is expected to increase by an annual average of 1 percent during construction and operation. | • **Tritium Supply and Upgraded Recycling**—Employment in the economic study area is expected to increase by 4,200 persons during peak construction and by 1,600 persons during full operation. Unemployment is expected to decrease to 4.2 percent during peak construction and then increase to 4.6 percent during full operation. Per capita income is expected to increase by an annual average of just under 1 percent during construction and operation. |
| • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 562,800 in 2010. Total housing units in the region-of-influence are expected to reach 240,500 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 2 percent over No Action during construction, and would not increase by more than 1 percent during operation. Population in the region-of-influence is expected to reach 207,200 in 2010. Total housing units in the region-of-influence are expected to reach 89,100 in 2010. | • Population and housing demand in the region-of-influence would not increase by more than 1 percent over No Action during construction and operation. Population in the region-of-influence is expected to reach 455,400 in 2010. Total housing units in the region-of-influence are expected to reach 181,600 in 2010. |
| • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of approximately 1 percent or less through 2010. Between 2010 and 2020 total revenues and expenditures are both expected to increase by annual averages of less than 1 percent. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent through 2020. | • Total revenues and expenditures for most region-of-influence counties, cities, and school districts are projected to increase by an annual average of less than 1 percent through 2020. |
| • Traffic conditions would worsen on site access roads, particularly on the primary access route, Bear Creek Road. | • Traffic conditions would worsen on site access roads, particularly on the primary access route, Farm-to-Market Road 683. | • Traffic conditions would worsen on site access roads, particularly on the primary access route, South Carolina Route 125. |
| • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **Tritium Supply Alone**—The effects on employment and income over No Action would be only slightly less than the effects of collocation with recycling. | • **No Tritium Supply Alone.** |
| • Population and housing demands would increase by no more than 1 percent over No Action during construction and operation. | • Population and housing demands would increase by more than 1 percent over No Action during construction and operation. | |
| • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | • Revenues and expenditures would increase for all region-of-influence county, city and school districts but these increases would be less than collocation with recycling. | |
| • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | • The effects on traffic onsite access routes would be slightly less than collocation with recycling. | |

**Socioeconomics**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium (Continued)** | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the collocated supply and recycling except during construction when the effects are fewer for employment, economics, revenues, and expenditures. | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the collocated supply and recycling except during construction when the effects are fewer for employment, economics, revenues, and expenditures. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would cause a loss of 900 jobs at SRS, unemployment would rise from 4.8 percent to 5 percent, per capita income would decrease $20, population and housing would decrease 1 percent, and there would be a less than 1 percent decrease in revenues and expenditures. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would cause a loss of 900 jobs at SRS, unemployment would rise from 4.8 percent to 5 percent, per capita income would decrease $20, population and housing would decrease 1 percent, and there would be a less than 1 percent decrease in revenues and expenditures. |
| **Radiological and Hazardous Chemical Impacts During Normal Operation** | | |
| **No Action (2010)** | • **Emissions of Radiation**—The dose to the maximally exposed member of the public from 1 year of operation is $6.0 \times 10^{-3}$ mrem. The associated risk of fatal cancers from 40 years of operation is $1.2 \times 10^{-7}$. | • **Emissions of Radiation**—The dose to the maximally exposed member of the public from 1 year of operation is 0.040 mrem. The associated risk of fatal cancers from 40 years of operation is $8.1 \times 10^{-7}$. |
| | • The annual population dose of 0.037 person-rem from total site operation in 2030 would result in $7.4 \times 10^{-4}$ fatal cancers over 40 years of operation. | • The annual population dose of $8.2 \times 10^{-3}$ person-rem from total site operation in 2030 would result in $1.6 \times 10^{-4}$ fatal cancers over 40 years of operation. |
| | • The average annual dose to a site worker is 30 mrem with an associated $4.8 \times 10^{-4}$ risk of fatal cancer from 40 years of operation. The annual dose of 220 person-rem to the total site workforce would result in 3.5 fatal cancers over 40 years of operation. | • The average annual dose to a site worker is 5 mrem with an associated $7.8 \times 10^{-5}$ risk of fatal cancer from 40 years of operation. The annual dose of 3 person-rem to the total site workforce would result in 0.048 fatal cancers over 40 years of operation. |
| | • **Emissions of Hazardous Chemicals**—The Hazard Index is $1.7 \times 10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.021 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The Hazard Index is 0 with no cancer risk to the maximally exposed member of the public or site worker. |

## Socioeconomics

| ORR | Pantex | SRS |
|---|---|---|
| • **Less Than Baseline Operations**—The effects are expected to remain the same as above for the collocated supply and recycling except during construction when the effects are fewer for employment, economics, revenues and expenditures. | • **Less Than Baseline Operations**—The effects are expected to remain the same as above for the collocated supply and recycling except during construction when the effects are fewer for employment, economics, revenues and expenditures. | • **Less Than Baseline Operations**—The impacts are expected to remain the same as above for the tritium supply and upgraded recycling facility except during operation when the effects are fewer for employment, economics, revenues and expenditures. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would cause a loss of 900 jobs at SRS, unemployment would rise from 4.8 percent to 5 percent, per capita income would decrease $20, population and housing would decrease 1 percent, and there would be a less than 1 percent decrease in revenues and expenditures. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would cause a loss of 900 jobs at SRS, unemployment would rise from 4.8 percent to 5 percent, per capita income would decrease $20, population and housing would decrease 1 percent, and there would be a less than 1 percent decrease in revenues and expenditures. | • **No Tritium Recycling Phaseout With SRS Alternatives.** |
| **Radiological and Hazardous Chemical Impacts During Normal Operation** | | |
| • **Emissions of Radiation**—The dose to the maximally exposed member of the public from 1 year of operation is 3.9 mrem from atmospheric release and 14 mrem from liquid release. The associated risk of fatal cancer from 40 years of operation is $7.8 \times 10^{-5}$ and $2.7 \times 10^{-4}$, respectively. | • **Emissions of Radiation**—The dose to the maximally exposed member of the public from 1 year of operation is $1.3 \times 10^{-3}$ mrem. The associated risk of fatal cancer from 40 years of operation is $2.6 \times 10^{-8}$. | • **Emissions of Radiation**—The dose to the maximally exposed member of the public from 1 year of operation is 2.8 mrem from atmospheric release and 0.077 mrem from liquid release. The associated risk of fatal cancer from 40 years of operation is $5.6 \times 10^{-5}$ and $1.5 \times 10^{-6}$, respectively. |
| • The annual population dose of 57 person-rem from total site operation in 2030 would result in 1.1 fatal cancers over 40 years of operation. | • The annual population dose of $5.7 \times 10^{-4}$ person-rem from total site operation in 2030 would result in $1.1 \times 10^{-5}$ fatal cancers over 40 years of operation. | • The annual population dose of 250 person-rem from total site operation in 2030 would result in 4.9 fatal cancers over 40 years of operation. |
| • The average annual dose to a site worker is 17 mrem with an associated $2.8 \times 10^{-4}$ risk of fatal cancer from 40 years of operation. The annual dose of 320 person-rem to the total site workforce would result in 5.1 fatal cancers over 40 years of operation. | • The average annual dose to a site worker is 15 mrem with an associated $2.4 \times 10^{-4}$ risk of fatal cancer from 40 years of operation. The annual dose of 37 person-rem to the total site workforce would result in 0.59 fatal cancers over 40 years of operation. | • The average annual dose to a site worker is 32 mrem with an associated $5.2 \times 10^{-4}$ risk of fatal cancer from 40 years of operation. The annual dose of 480 person-rem to the total site workforce would result in 7.7 fatal cancers over 40 years of operation. |
| • **Emissions of Hazardous Chemicals**—The Hazard Index is 0.36 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.26 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The Hazard Index is 0.030 and a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 and the cancer risk is 0.010. The site worker cancer risk exceeds the typical threshold of regulatory concern. | • **Emissions of Hazardous Chemicals**—The Hazard Index is 0.70 and a cancer risk of $3.3 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is $5.9 \times 10^{-3}$. All values exceed the typical threshold of regulatory concern except for the Hazard Index to the maximally exposed member of the public. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting om no adverse health effects. |
| | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.29 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $5.9 \times 10^{-6}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.31 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $6.2 \times 10^{-6}$. |
| | • The annual population dose of 53 person-rem from total site operation in 2030 would result in 1.1 fatal cancers over 40 years of operation. | • The annual population dose of 0.20 person-rem from total site operation in 2030 would result in $4.0 \times 10^{-3}$ fatal cancers over 40 years of operation. |
| | • The average annual dose to a site worker would be 33 mrem with an associated $5.2 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 261 person-rem to the total site workforce would result in 4.2 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 34 mrem with an associated $5.4 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 44 person-rem to the total site workforce would result in 0.7 fatal cancers over 40 years of operation. |
| | • **Emissions of Hazardous Chemicals**—The Hazard Index is $2.1 \times 10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.031 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The Hazard Index is $6.3 \times 10^{-6}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is $3.2 \times 10^{-3}$ with no cancer risk. These values are within regulatory limits. |
| | • **Tritium Supply Alone Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply and Upgraded Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 7.1 mrem from atmospheric release and 14 mrem from liquid release. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.4 \times 10^{-4}$ and $2.7 \times 10^{-4}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 3.8 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $7.6 \times 10^{-5}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 3.4 mrem from atmospheric release and 0.16 mrem from liquid release. This is within DOE Order 5400.5 regulatory limits. The associated risk of fatal cancer from 40 years of operation is $6.9 \times 10^{-5}$ and $3.3 \times 10^{-6}$, respectively. |
| • The annual population dose of 82 person-rem from total site operation in 2030 would result in 1.6 fatal cancers over 40 years of operation. | • The annual population dose of 28 person-rem from total site operation in 2030 would result in 0.55 fatal cancers over 40 years of operation. | • The annual population dose of 300 person-rem from total site operation in 2030 would result in 6.1 fatal cancers over 40 years of operation. |
| • The average annual dose to a site worker would be 19 mrem with an associated $3.0 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 360 person-rem to the total site workforce would result in 5.8 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 25 mrem with an associated $4.0 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 78 person-rem to the total site workforce would result in 1.2 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 34 mrem with an associated $5.4 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 520 person-rem to the total site workforce would result in 8.3 fatal cancers over 40 years of operation. |
| • **Emissions of Hazardous Chemicals**—The Hazard Index is 0.36 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.27 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The Hazard Index is 0.031 with a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 and the cancer risk is 0.010. The HI values are within regulatory limits, but the cancer risks to both the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • **Emissions of Hazardous Chemicals**—The Hazard Index is 0.70 with a cancer risk of $3.3 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is $5.9 \times 10^{-3}$. The HI value for the public is within regulatory limits, however, the worker HI exceeds OSHA's action level of 1.0. The cancer risks to both the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. |
| • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **No Tritium Supply Alone.** |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.18 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $3.7 \times 10^{-6}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.19 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $3.8 \times 10^{-6}$. |
| | • The annual population dose of 31 person-rem from total site operation in 2030 would result in 0.66 fatal cancers over 40 years of operation. | • The annual population dose of 0.13 person-rem from total site operation in 2030 would result in $2.6 \times 10^{-3}$ fatal cancers over 40 years of operation. |
| | • The average annual dose to a site worker would be 34 mrem with an associated $5.4 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 260 person-rem to the total site workforce would result in 4.2 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 47 mrem with an associated $7.5 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 42 person-rem to the total site workforce would result in 0.67 fatal cancers over 40 years of operation. |
| | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index to the maximally exposed member of the public would be reduced by 0.3 percent and the site worker Hazard Index reduced by 0.15 percent with no cancer risk to either. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index to the maximally exposed member of the public would be reduced by 1.4 percent and the site worker Hazard Index reduced by 0.5 percent with no cancer risk to either. These values are within regulatory limits. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.19 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $3.8 \times 10^{-6}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.21 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $4.1 \times 10^{-6}$. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • The dose to the maximally exposed member of the public from 1 year of operation would be 4.3 mrem from atmospheric release and 14 mrem from liquid release. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $8.4 \times 10^{-5}$ and $2.7 \times 10^{-4}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 2.4 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $4.8 \times 10^{-5}$ | |
| • The annual population dose of 71 person-rem from total site operation in 2030 would result in 1.4 fatal cancers over 40 years of operation. | • The annual population dose of 19 person-rem from total site operation in 2030 would result in 0.37 fatal cancers over 40 years of operation. | |
| • The average annual dose to a site worker would be 19 mrem with an associated $3.0 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 360 person-rem to the total site workforce would result in 5.8 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 28 mrem with an associated $4.5 \times 10^{-4}$ risk of fatal cancer over 40 years of operation; the annual dose of 76 person-rem to the total site workforce would result in 1.2 fatal cancers over 40 years of operation. | |
| • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Indexes to the maximally exposed member of the public and the site worker would both be reduced by about 0.01 percent with no cancer risk to either. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the maximally exposed member of the public would be reduced by about 10 percent and that to the site worker by about 0.003 percent with no change in either of the cancer risk values. The Hazard Index values are within regulatory limits. The cancer risks to the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • **No Tritium Supply Alone.** |
| • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply and Upgraded Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 5.7 mrem from atmospheric release and 14 mrem from liquid release. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.1 \times 10^{-4}$ and $2.7 \times 10^{-4}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 2.4 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $4.8 \times 10^{-5}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 3.0 mrem from atmospheric release and 0.077 mrem from liquid release. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $5.9 \times 10^{-5}$ and $1.5 \times 10^{-6}$, respectively. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • The annual population dose of 37 person-rem from total site operation in 2030 would result in 0.73 fatal cancers over 40 years of operation.<br>• The average annual dose to a site worker would to be 31 mrem with an associated $5.0 \times 10^{-4}$ risk of fatal cancer from 40 years of operation. The annual dose of 250 person-rem the total site workforce would result in 4.0 fatal cancers over 40 years of operation.<br>• **Emissions of Hazardous Chemicals**—The calculated Hazard Index is $1.8 \times 10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.021 with no cancer risk. These values are within regulatory limits. | • The annual population dose of 0.13 person-rem from total site operation in 2030 would result in $2.6 \times 10^{-3}$ fatal cancers over 40 years of operation.<br>• The average annual dose to a site worker would to be 26 mrem with an associated $4.2 \times 10^{-4}$ risk of fatal cancer from 40 years of operation. The annual dose of 33 person-rem the total site workforce would result in 0.53 fatal cancers over 40 years of operation.<br>• **Emissions of Hazardous Chemicals**—The calculated Hazard Index is $2.2 \times 10^{-7}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is $3.4 \times 10^{-5}$ with no cancer risk. These values are within regulatory limits. |
| | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects.<br>• The dose to the maximally exposed member of the public from 1 year of operation would be 0.08 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.6 \times 10^{-6}$. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects.<br>• The dose to the maximally exposed member of the public from 1 year of operation would be 0.09 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.7 \times 10^{-6}$. |
| | • The annual population dose of 15 person-rem from total site operation in 2030 would result in 0.29 fatal cancers over 40 years of operation.<br>• The average annual dose to a site worker would be 33 mrem with an associated $5.3 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 250 person-rem the total site workforce would result in 4.0 fatal cancers over 40 years of operation. | • The annual population dose of 0.06 person-rem from total site operation in 2030 would result in $1.2 \times 10^{-3}$ fatal cancers over 40 years of operation.<br>• The average annual dose to a site worker would be 37 mrem with an associated $6.0 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 31 person-rem the total site workforce would result in 0.50 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • The annual population dose of 76 person-rem from total site operation in 2030 would result in 1.5 fatal cancers over 40 years of operation. | • The annual population dose of 16 person-rem from total site operation in 2030 would result in 0.31 fatal cancers over 40 years of operation. | • The annual population dose of 260 person-rem from total site operation in 2030 would result in 5.2 fatal cancers over 40 years of operation. |
| • The average annual dose to a site worker would to be 18 mrem with an associated $2.9 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 350 person-rem to the total site workforce would result in 5.6 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would to be 22 mrem with an associated $3.5 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 67 person-rem the total site workforce would result in 1.1 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would to be 33 mrem with an associated $5.3 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 510 person-rem the total site workforce would result in 8.2 fatal cancers over 40 years of operation. |
| • **Emissions of Hazardous Chemicals**—The calculated Hazard Index is 0.36 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.32 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index is 0.03 with a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 and the cancer risk is 0.010. The HI values are within regulatory limits, however the cancer risks to the public and site workers both exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index is 0.70 with a cancer risk of $3.3 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is $5.9 \times 10^{-3}$. The HI value for the public is within regulatory limits, however, the HI value to the worker exceeds the action level of 1.0 based on OSHA's exposure limits. Cancer risks to the public and site workers both exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. |
| • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **No Tritium Supply Alone.** |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 2.9 mrem from atmospheric release and 14 mrem from liquid release. This is within DOE Order 5400.5 regulatory limits. The associated risk of fatal cancer from 40 years of operation is $5.4 \times 10^{-5}$ and $2.7 \times 10^{-4}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 1.0 mrem. This is within DOE Order 5400.5 regulatory limits. The associated risk of fatal cancer from 40 years of operation is $2.0 \times 10^{-6}$. | |
| • The annual population dose of 65 person-rem from total site operation in 2030 would result in 1.3 fatal cancers over 40 years of operation. | • The annual population dose of 7 person-rem from total site operation in 2030 would result in 0.13 fatal cancers over 40 years of operation. | |
| • The average annual dose to a site worker would be 19 mrem with an associated $3.0 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 350 person-rem to the total site workforce would result in 5.6 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 24 mrem with an associated $3.9 \times 10^{-4}$ risk of fatal cancer of 40 years of operation; the annual dose of 65 person-rem the total site workforce would result in 1.1 fatal cancers over 40 years of operation. | |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the maximally exposed member of the public would be reduced by about 0.03 percent and that for the site worker by 0.15 percent. There are no cancer risks. The resulting values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the maximally exposed member of the public would be reduced by about 41 percent and that for the site worker by 50 percent. There are no cancer risks. The resulting values are within regulatory limits. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.36 mrem for the Large or Small ALWR. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $7.3 \times 10^{-6}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.40 mrem for the Large or Small ALWR. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $8.0 \times 10^{-6}$. |
| | • The annual population dose of 73 and 71 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 1.5 and 1.4 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 0.24 and 0.25 person-rem for the Large and Small ALWR from total site operation in 2030 would result in $4.9 \times 10^{-3}$ and $5.1 \times 10^{-3}$ fatal cancers, respectively, over 40 years of operation. |
| | • The average annual dose to a site worker of 49 and 41 mrem for the Large and Small ALWRs would result in an associated fatal cancer risk of $7.9 \times 10^{-4}$ and $6.6 \times 10^{-4}$, respectively, from 40 years of operation; the annual dose of 392 and 322 person-rem to the total site workforce would result in 6.3 and 5.2 fatal cancers over 40 years of operation. | • The average annual dose to a site worker of 140 and 92 mrem for the Large and Small ALWRs would result in associated risk of fatal cancer risk of $2.3 \times 10^{-3}$ and $1.5 \times 10^{-3}$, respectively, from 40 years of operation; the annual dose of 180 and 100 person-rem to the total site workforce would result in 2.8 and 1.7 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Indexes for the maximally exposed member of the public and site worker would both be reduced by about 0.01 percent. There are no cancer risks. The resulting values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index to the maximally exposed member of the public would be reduced by about 10.6 percent and that for the site worker by about 0.003 percent. The cancer risks to the public and the site worker would not change and therefore exceed the typical threshold of regulatory concern of $1x10^{-6}$. The resulting HI values are within regulatory limits. | • **No Tritium Supply Alone.** |
| • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply and Upgraded Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 8.8 and 7.6 mrem for the Large and Small ALWR from atmospheric release and 14 mrem from liquid release, for both sizes. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.8x10^{-4}$, $1.5x10^{-4}$, and $2.8x10^{-4}$ for these doses. | • The dose to the maximally exposed member of the public from 1 year of operation would be 4.9 and 4.8 mrem for the Large and Small ALWR, respectively. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $9.8x10^{-5}$ and $9.6x10^{-5}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 3.9 and 3.6 mrem for the Large and Small ALWR from atmospheric release and 0.16 and 0.26 mrem from liquid release, respectively. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $7.8x10^{-5}$, $7.1x10^{-5}$, $3.3x10^{-6}$ and $5.39x10^{-6}$ for these doses. |
| • The annual population dose of 90 and 87 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 1.8 and 1.7 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 37 and 35 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 0.73 and 0.69 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 340 and 310 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 6.8 and 6.2 fatal cancers, respectively, over 40 years of operation. |
| • The average annual dose to a site worker of 26 and 22 mrem for the Large and Small ALWRs would result in an associated fatal cancer risk of $4.2x10^{-4}$ and $3.6x10^{-4}$, respectively, from 40 years of operation; the annual dose of 490 and 420 person-rem to the total site workforce would result in 7.9 and 6.7 fatal cancers over 40 years of operation. | • The average annual dose to a site worker of 68 and 46 mrem for the Large and Small ALWRs would result in an associated fatal cancer risk of $1.1x10^{-3}$ and $7.4x10^{-4}$, respectively, from 40 years of operation; the annual dose of 210 and 140 person-rem to the total site workforce would result in 3.3 and 2.2 fatal cancers over 40 years of operation. | • The average annual dose to a site worker of 42 and 38 mrem for the Large and Small ALWRs would result in an associated fatal cancer risk of $6.7x10^{-4}$ and $6.1x10^{-4}$, respectively, from 40 years of operation; the annual dose of 650 and 580 person-rem to the total site workforce would result in 10 and 9.3 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor (Continued)** | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for either ALWR is $6.3 \times 10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.13 with a cancer risk of 0. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for the ALWR is $7.7 \times 10^{-5}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.038 with no cancer risk. These values are within regulatory limits. |
| | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.25 mrem for the Large or Small ALWR. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $5.1 \times 10^{-6}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.28 mrem for the Large or Small ALWR. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $5.6 \times 10^{-6}$. |
| | • The annual population dose of 51 and 49 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 1.1 and 0.96 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 0.17 and 0.18 person-rem for the Large and Small ALWR from total site operation in 2030 would result in $3.5 \times 10^{-3}$ and $3.7 \times 10^{-3}$ fatal cancers over 40 years of operation. |
| | • The average annual dose to a site worker of 52 and 43 mrem for the Large and Small ALWRs would result in an associated fatal cancer risk of $8.3 \times 10^{-4}$ and $6.9 \times 10^{-4}$, respectively, from 40 years of operation; the annual dose of 390 and 320 person-rem to the total site workforce would result in 6.3 and 5.2 fatal cancers over 40 years of operation | • The average annual dose to a site worker of 220 and 130 mrem for the Large and Small ALWRs would result in associated 40-year risk of fatal cancer risk of $3.5 \times 10^{-3}$ and $2.2 \times 10^{-3}$, respectively, from 40 years of operation; the annual dose of 180 and 98 person-rem to the total site workforce would result in 2.8 and 1.7 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for either ALWR is 0.38 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.35 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for either ALWR is 0.036 with a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 and the cancer risk is 0.010. The Hazard Index values are within regulatory limits, however, the cancer risk to the public and site worker both exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for either ALWR is 0.71 with a cancer risk of $3.3 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is $6.0 \times 10^{-3}$. The Hazard Index value for the public is within regulatory limits, however, the Hazard Index value to the worker exceeds the level of 1.0 based on OSHA's exposure limits. Cancer risks to the public and site workers both exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. |
| • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **No Tritium Supply Alone.** |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 6.0 and 4.8 mrem for the Large and Small ALWR from atmospheric release and 14 mrem from liquid release for both sizes. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.2 \times 10^{-4}$, $9.4 \times 10^{-5}$ and $2.8 \times 10^{-4}$. | • The dose to the maximally exposed member of the public from 1 year of operation would be 3.5 and 3.4 mrem for the Large and Small ALWR, respectively. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $7.0 \times 10^{-5}$ and $6.8 \times 10^{-5}$. | |
| • The annual population dose of 79 and76 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 1.6 and 1.5 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 28 and 26 person-rem for the Large and Small ALWRs from total site operation in 2030 would result in 0.55 and 0.51 fatal cancers, respectively, over 40 years of operation. | |
| • The average annual dose to a site worker 26 and 23 mrem for the Large and Small ALWRs would result in associated $4.3 \times 10^{-4}$ and $3.7 \times 10^{-4}$ fatal cancers respectively from 40 years of operation; the annual dose of 490 and 420 person-rem to the total site workforce would result in 7.9 and 6.7 fatal cancers over 40 years of operation. | • The average annual dose to a site worker of 78 and 53 mrem for the Large and Small ALWRs would result in an associated fatal cancer risk of $1.3 \times 10^{-3}$ and $8.6 \times 10^{-4}$, respectively; the annual dose of 210 and 140 person-rem to the total site workforce would result in 3.3 and 2.2 fatal cancers over 40 years of operation. | |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
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| **Advanced Light Water Reactor (Continued)** | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the public would be reduced by about 0.1 percent and that for the worker by about 0.3 percent. There are no cancer risks. The resulting values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to collocated supply and recycling, the Hazard Index for the public would be reduced by about 0.1 percent and that for the worker by about 0.04 percent. There are no cancer risks. The resulting values are within regulatory limits. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.16 mrem with a SILC target and 0.11 mrem with a helium-3 target. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $3.3 \times 10^{-6}$ and $2.3 \times 10^{-6}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.18 mrem with a SILC target and 0.13 mrem with a helium-3 target. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $3.6 \times 10^{-6}$ and $2.6 \times 10^{-6}$, respectively. |
| | • The annual population dose of 32 person-rem with a SILC target and 23 person-rem with a helium-3 target from total site operation in 2030 would result in 0.64 and 0.45 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 0.11 person-rem with a SILC target and 0.08 person-rem with a helium-3 target from total site operation in 2030 would result in $2.3 \times 10^{-3}$ and $1.6 \times 10^{-3}$ fatal cancers, respectively, over 40 years of operation. |
| | • The average annual dose to a site worker for SILC target and helium-3 target are 34 mrem with an associated $5.5 \times 10^{-4}$ and $5.4 \times 10^{-4}$ risk of fatal cancer from 40 years of operation, respectively; The annual doses of 274 and 273 person-rem to the total site workforce would result in 4.2 fatal cancers over 40 years of operation. | • The average annual dose to a site worker for SILC and helium-3 target target are 44 and 43 mrem respectively with an associated $7.0 \times 10^{-4}$ and $6.9 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 57 and 56 person-rem to the total site workforce would result in 0.91 and 0.90 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index would be reduced by less than 0.01 percent for either the maximally exposed member of the public or site worker. There are no cancer risks. The resulting values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the public would be reduced by about 9.3 percent and that for the site worker by about 0.003 percent. The HI values are within regulatory limits, however the cancer risks to the public and site workers exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • **No Tritium Supply Alone.** |
| • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Collocated Tritium Supply and Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply and Upgraded Recycling For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 5.0 and 4.3 mrem from atmospheric release with a SILC and helium-3 target, respectively, and 14 mrem from liquid release with either target. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer is $1.0 \times 10^{-4}$ and $8.6 \times 10^{-5}$ for the atmospheric release with the respective targets and $2.8 \times 10^{-4}$ for the liquid release with either target. | • The dose to the maximally exposed member of the public from 1 year of operation would be 2.1 mrem with a SILC target and 1.4 mrem with a helium-3 target. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $4.2 \times 10^{-5}$ and $2.9 \times 10^{-5}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 2.8 and 2.5 mrem from atmospheric release with a SILC and helium-3 target, respectively, and 0.077 mrem from liquid release for both targets. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $5.6 \times 10^{-5}$, $4.9 \times 10^{-5}$, and $1.5 \times 10^{-6}$, respectively. |
| • The annual population dose of 73 person-rem with a SILC target and 68 person-rem with a helium-3 target from total site operation in 2030 would result in 1.5 and 1.4 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 14 person-rem with a SILC target and 9.2 person-rem with a helium-3 target from total site operation in 2030 would result in 0.27 and 0.18 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 250 person-rem with a SILC and 220 person-rem with a helium-3 target, from total site operation in 2030 would result in 4.9 and 4.4 fatal cancers respectively, over 40 years of operation. |
| • For either target, the average annual dose to a site worker would be 20 mrem with an associated $3.1 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 373 and 372 person-remfor SILC at helium-3 target, respectively, to the total site workforce would result in 6.0 fatal cancers over 40 years of operation. | • For either target, the average annual dose to a site worker would be 29 mrem with an associated $4.6 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 91 and 90 person-rem for SILC and helium-3 targets, respectively, to the total site workforce would result in 1.5 and 1.4 fatal cancers over 40 years of operation. | • For the SILC and helium-3 targets, the average annual dose to a site worker would be 34 mrem with an associated $5.4 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 534 and 533 person-rem, respectively, to the total site workforce would result in 8.5 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium (Continued)** | • **Emissions of Hazardous Chemicals**—The Hazard Index for either target is $1.8 \times 10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.021 with no cancer risk. These values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—The Hazard Index for either target is $1.8 \times 10^{-7}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is $3.4 \times 10^{-5}$ with no cancer risk. These values are within regulatory limits. |
| | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. |
| | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.05 mrem with a SILC target and $4.8 \times 10^{-3}$ mrem with a helium-3 target from 40 years of operation. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.1 \times 10^{-6}$ and $1.0 \times 10^{-7}$, respectively. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.06 mrem with a SILC target and 0.01 mrem with a helium-3 target from 40 years of operation. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.2 \times 10^{-6}$ and $2.0 \times 10^{-7}$, respectively. |
| | • The annual population dose of 10 person-rem with a SILC target and 1 person-rem with a helium-3 target from total site operation in 2030 would result in 0.2 and 0.01 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 0.04 person-rem with a SILC target and 0.01 person-rem with a helium-3 target from total site operation in 2030 would result in $9.0 \times 10^{-4}$ and $2.0 \times 10^{-4}$ fatal cancers, respectively, over 40 years of operation. |
| | • For either target, the average annual dose to a site worker would be 36 mrem with an associated $5.8 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 270 person-rem to the total site workforce would result in 4.4 fatal cancers over 40 years of operation. | • The average annual dose to a site worker would be 62 mrem with the SILC target and 60 mrem with a helium-3 target with an associated $9.9 \times 10^{-4}$ and $9.7 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual doses of 55 and 54 person-rem to the total site workforce would result in 0.88 and 0.87 fatal cancers over 40 years of operation. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • **Emissions of Hazardous Chemicals**—The Hazard Index for either target is 0.36 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.26 with no cancer risk. These values are within regulatory limits | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for either target is 0.030 with a cancer risk of $1.1 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 and the cancer risk is 0.010. The HI values are within regulatory limits, however, the cancer risks to the public and site worker exceed the typical threshold of regulatory concern of $1 \times 10^{-6}$. | • **Emissions of Hazardous Chemicals**—The calculated Hazard Index for either target is 0.70 with a cancer risk of $3.3 \times 10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is $5.9 \times 10^{-3}$. The Hazard Index value for the public is within regulatory limits, however, the Hazard Index value to the worker exceeds the action level of 1.0 based on OSHA's exposure limits. The cancer risks to the public and site worker exceed the typical threshold of regulatory concern of $1 \times 10^{-6}$. |
| • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **Tritium Supply Alone For Emissions of Radiation**—There would be no radiological releases during construction. Limited hazardous chemical releases are anticipated and would be within regulated exposure limits resulting in no adverse health effects. | • **No Tritium Supply Alone.** |
| • The dose to the maximally exposed member of the public from 1 year of operation would be 2.2 and 1.5 mrem from atmospheric release with a SILC and helium-3 target, respectively, and 14 mrem from liquid release with either target. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer is $4.4 \times 10^{-5}$ and $3.0 \times 10^{-5}$ for the atmospheric release with the respective targets and $2.8 \times 10^{-4}$ for the liquid release with either target from 40 years of operation. | • The dose to the maximally exposed member of the public from 1 year of operation would be 0.7 mrem with a SILC target and 0.048 mrem with a helium-3 target. This is within DOE Order 5400.5 limits. The associated risk of fatal cancer from 40 years of operation is $1.4 \times 10^{-5}$ and $1.0 \times 10^{-6}$, respectively. | |
| • The annual population dose of 62 person-rem with a SILC target and 57 person-rem with a helium-3 target from total site operation in 2030 would result in 1.3 and 1.2 fatal cancers, respectively, over 40 years of operation. | • The annual population dose of 5 person-rem with a SILC target and 0.2 person-rem with a helium-3 target from total site operation in 2030 would result in 0.09 and $3.9 \times 10^{-3}$ fatal cancers, respectively, over 40 years of operation. | |
| • For either target, the average annual dose to a site worker would be 20 mrem with an associated $3.1 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 370 person-rem to the total site workforce would result in 6.0 fatal cancers over 40 years of operation. | • The average annual dose to a site workers would be 33 mrem with the SILC target and 32 mrem with the helium-3 target with an associated $5.2 \times 10^{-4}$ and $5.1 \times 10^{-4}$ risk of fatal cancer from 40 years of operation; the annual dose of 89 and 88 person-rem, respectively, to the total site workforce would result in 1.5 and 1.4 fatal cancers over 40 years of operation. | |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium (Continued)** | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the maximally exposed member of the public would be reduced by about 0.3 percent and that for the worker by about 0.2 percent. There are no cancers. The resulting values are within regulatory limits. | • **Emissions of Hazardous Chemicals**—Relative to the collocated supply and recycling, the Hazard Index for the maximally exposed member of the public would be reduced by about 51 percent and that for the site worker by about 50 percent. There are no cancer risks. The resulting values are within regulatory limits. |
| **All Supply Technologies** | • **Less Than Baseline Operations**—Radiological and hazardous chemical impacts from less than baseline operations with the HWR, MHTGR or ALWR would be identical for each site. | • **Less Than Baseline Operations**—Radiological and hazardous chemical impacts from less than baseline operations with the HWR, MHTGR or ALWR would be identical for each site (see INEL). |
| | • The impacts from the HWR operating at the reduced tritium production capacity to meet a less than baseline operation requirement would be proportional to the level of operation, approximately 40 percent of baseline. | • The impacts from the HWR operating at the reduced tritium production capacity to meet a less than baseline operation requirement would be proportional to the level of operation, approximately 40 percent of baseline. |
| | • The normal operation impacts of the ALWR or three reactor module MHTGR would not change because the reactor would maintain power requirements to produce steam or electricity. | • The normal operation impacts of the ALWR or three reactor module MHTGR would not change because the reactor would maintain power requirements to produce steam or electricity. |
| | • For the Phased APT with recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 0.11 mrem and would result in an associated risk of fatal cancer from 40 years of operation of $2.3 \times 10^{-6}$. The dose is within DOE Order 5400.5 limits. | • For the Phased APT with recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 0.13 mrem and would result in an associated risk of fatal cancer from 40 years of operation of $2.6 \times 10^{-6}$. The dose is within DOE Order 5400.5 limits. |
| | The annual population dose of 23 person-rem to the total site operation in 2030 would result in 0.45 fatal cancers over 40 years of operation. | The annual population dose of 0.080 person-rem from total site operation in 2030 would result in $1.6 \times 10^{-3}$ fatal cancers over 40 years of operation. |
| | The average annual dose to a site worker would be 34 mrem with an associated $5.3 \times 10^{-4}$ 40-year risk of fatal cancer from 40 years of operation; the annual dose of 273 person-rem to the total site workforce would result in 4.4 fatal cancers over 40 years of operation. | The average annual dose to a site worker would be 43 mrem with an associated $6.9 \times 10^{-4}$ 40-year risk of fatal cancer from 40 years of operation; the annual dose of 56 person-rem to the total site workforce would result in 0.90 fatal cancers over 40 years of operation. |
| | Impacts from hazardous chemical emissions would be identical to those associated with the Full APT. | Impacts from hazardous chemical emissions would be identical to those associated with the Full APT. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • **Emissions of Hazardous Chemicals—** Should the recycling process not be included, the Hazard Indexes for the maximally exposed member of the public and site worker would be reduced by about 0.01 percent for each and for either target. The resulting values are within regulatory limits. | • **Emissions of Hazardous Chemicals—** Should recycling processes not be included, the Hazard Indexes for the public would be reduced by about 10 percent and that of site workers by about 0.003 percent. The resulting values are within regulatory limits. The cancer risks for both the public and site worker, however, exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations—** Radiological and hazardous chemical impacts from less than baseline operations with the HWR, MHTGR or ALWR would be identical for each site (see INEL). | • **Less Than Baseline Operations—** Radiological and hazardous chemical impacts from less than baseline operations with the HWR, MHTGR or ALWR would be identical for each site (see INEL). | • **Less Than Baseline Operations—** Radiological and hazardous chemical impacts from less than baseline operations with the HWR, MHTGR or ALWR would be identical for each site (see INEL). |
| • The impacts from the HWR operating at the reduced tritium production capacity to meet a less than baseline operation requirement would be proportional to the level of operation, approximately 40 percent of baseline. | • The impacts from the HWR operating at the reduced tritium production capacity to meet a less than baseline operation requirement would be proportional to the level of operation, approximately 40 percent of baseline. | • The impacts from the HWR operating at the reduced tritium production capacity to meet a less than baseline operation requirement would be proportional to the level of operation, approximately 40 percent of baseline. |
| • The normal operation impacts of the ALWR or three reactor module MHTGR would not change because the reactor would maintain power requirements to produce steam or electricity. | • The normal operation impacts of the ALWR or three reactor module MHTGR would not change because the reactor would maintain power requirements to produce steam or electricity. | • The normal operation impacts of the ALWR or three reactor module MHTGR would not change because the reactor would maintain power requirements to produce steam or electricity. |
| • For the Phased APT with recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 4.3 and 14 mrem from atmospheric and liquid releases, respectively, and would result in an associated risk of fatal cancer from 40 years of operation of $8.6 \times 10^{-5}$ and $2.8 \times 10^{-4}$. The doses are within DOE Order 5400.5 limits. | • For the Phased APT with recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 1.4 mrem and would result in an associated risk of fatal cancer from 40 years of operation of $2.9 \times 10^{-5}$. The doses are within DOE Order 5400.5 limits. | • For the Phased APT with recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 2.5 and 0 mrem from atmospheric and liquid releases, respectively, and would result in an associated risk of fatal cancer from 40 years of operation of $4.9 \times 10^{-5}$ and 0. The doses are within DOE Order 5400.5 limits. |
| The annual population dose of 68 person-rem from total site operation in 2030 would result in 1.4 fatal cancers over 40 years of operation. | The annual population dose of 9.2 person-rem from total site operation in 2030 would result in 0.18 fatal cancers over 40 years of operation. | The annual population dose of 220 person-rem from total site operation in 2030 would result in 4.4 fatal cancers over 40 years of operation. |
| The average annual dose to a site worker would be 19 mrem with an associated $3.0 \times 10^{-4}$ 40-year risk of fatal cancer from 40 years of operation; the annual dose of 360 person-rem to the total site workforce would result in 5.8 fatal cancers over 40 years of operation. | The average annual dose to a site worker would be 26 mrem with an associated $4.1 \times 10^{-4}$ 40-year risk of fatal cancer from 40 years of operation; the annual dose of 79 person-rem to the total site workforce would result in 1.3 fatal cancers over 40 years of operation. | The average annual dose to a site worker would be 34 mrem with an associated $5.4 \times 10^{-4}$ 40-year risk of fatal cancer from 40 years of operation; the annual dose of 520 person-rem to the total site workforce would result in 8.4 fatal cancers over 40 years of operation. |
| Impacts from hazardous chemical emissions would be identical to those associated with the Full APT. | Impacts from hazardous chemical emissions would be identical to those associated with the Full APT. | Impacts from hazardous chemical emissions would be identical to those associated with the Full APT. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| Technology | INEL | NTS |
|---|---|---|
| **All Supply Technologies (Continued)** | • For the Phased APT without recycling, the dose to the maximally exposed member of the public from 1 year of operation would be $4.8 \times 10^{-3}$ mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancers from 40 years of operation is $1.0 \times 10^{-7}$.<br><br>The annual population dose of 1.0 person-rem from total site operation in 2030 would result in 0.010 fatal cancers over 40 years of operation.<br><br>The average annual dose to a site worker is 36 mrem with an associated $5.7 \times 10^{-4}$ risk of fatal cancer over 40 years of operation; the annual dose of 270 person-rem to the total site workforce would result in 4.4 fatal cancers over 40 years of operation. | • For the Phased APT without recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 0.010 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancers from 40 years of operation is $2.0 \times 10^{-7}$.<br><br>The annual population dose of 0.010 person-rem from total site operation in 2030 would result in $2.0 \times 10^{-4}$ fatal cancers over 40 years of operation.<br><br>The average annual dose to a site worker is 60 mrem with an associated $9.7 \times 10^{-4}$ risk of fatal cancer over 40 years of operation; the annual dose of 54 person-rem to the total site workforce would result in 0.87 fatal cancers over 40 years of operation. |
| | • **Tritium Extraction and Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. The phaseout of recycling at SRS would decrease the annual dose to the maximally exposed member of the public located at SRS by 2.4 mrem from No Action, lowering the associated 40-year fatal cancer risk by $4.0 \times 10^{-5}$. The annual population dose to the population surrounding SRS in 2030 would decrease by 210 person-rem, resulting in 4.2 fewer fatal cancers over a forty year period. The doses and associated health effects among site workers would remain virtually the same as No Action. | • **Tritium Extraction and Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. The phaseout of recycling at SRS would decrease the annual dose to the maximally exposed member of the public located at SRS by 2.4 mrem from No Action, lowering the associated 40-year fatal cancer risk by $4.0 \times 10^{-5}$. The annual population dose to the population surrounding SRS in 2030 would decrease by 210 person-rem, resulting in 4.2 fewer fatal cancers over a forty year period. The doses and associated health effects among site workers would remain virtually the same as No Action. |
| | • Any reduction in the emissions of hazardous chemicals is so small that it fails to change the Hazard Index or cancer risk to the public or site worker. This action applies to any collocated tritium supply and new recycling at INEL. | • Any reduction in the emissions of hazardous chemicals is so small that it fails to change the Hazard Index or cancer risk to the public or site worker. This action applies to any collocated tritium supply and new recycling at NTS. |

**Radiological and Hazardous Chemical Impacts During Normal Operation**

| ORR | Pantex | SRS |
|---|---|---|
| • For the Phased APT without recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 15. mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancers from 40 years of operation is $3.0 \times 10^{-4}$.<br><br>The annual population dose of 57 person-rem from total site operation in 2030 would result in 1.2 fatal cancers over 40 years of operation.<br><br>The average annual dose to a site worker is 20 mrem with an associated $3.1 \times 10^{-4}$ risk of fatal cancer over 40 years of operation; the annual dose of 370 person-rem to the total site workforce would result in 6.0 fatal cancers over 40 years of operation. | • For the Phased APT without recycling, the dose to the maximally exposed member of the public from 1 year of operation would be 0.048 mrem. This is within DOE Order 5400.5 limits. The associated risk of fatal cancers from 40 years of operation is $1.0 \times 10^{-6}$.<br><br>The annual population dose of 0.20 person-rem from total site operation in 2030 would result in $3.9 \times 10^{-3}$ fatal cancers over 40 years of operation.<br><br>The average annual dose to a site worker is 32 mrem with an associated $5.1 \times 10^{-4}$ risk of fatal cancer over 40 years of operation; the annual dose of 87 person-rem to the total site workforce would result in 1.4 fatal cancers over 40 years of operation. | • |
| • **Tritium Extraction and Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. The phaseout of recycling at SRS would decrease the annual dose to the maximally exposed member of the public located at SRS by 2.4 mrem from No Action, lowering the associated 40-year fatal cancer risk by $4.0 \times 10^{-5}$. The annual population dose to the population surrounding SRS in 2030 would decrease by 210 person-rem, resulting in 4.2 fewer fatal cancers over a forty year period. The doses and associated health effects among site workers would remain virtually the same as No Action. | • **Tritium Extraction and Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. The phaseout of recycling at SRS would decrease the annual dose to the maximally exposed member of the public located at SRS by 2.4 mrem from No Action, lowering the associated 40-year fatal cancer risk by $4.0 \times 10^{-5}$. The annual population dose to the population surrounding SRS in 2030 would decrease by 210 person-rem, resulting in 4.2 fewer fatal cancers over a forty year period. The doses and associated health effects among site workers would remain virtually the same as No Action. | • **No Tritium Extraction and Recycling Phaseout With SRS Alternatives.** |
| • Any reduction in the emissions of hazardous chemicals is so small that it fails to change the Hazard Index or cancer risk to the public or site worker. This action applies to any collocated tritium supply and new recycling at ORR. | • Any reduction in the emissions of hazardous chemicals is so small that it fails to change the Hazard Index or cancer risk to the public or site worker. This action applies to any collocated tritium supply and new recycling at Pantex. | |

**Radiological and Hazardous Chemical Impacts — Accidents**

| Technology | INEL | NTS |
|---|---|---|
| | • No impact. | • No impact. |
| | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences*: The dose to a maximally exposed individual at the site boundary would be 0.020 rem, which would result in an increased likelihood of cancer fatality of $9.9 \times 10^{-6}$. Given an accident probability of 0.01 per year, the cancer risk would be $9.9 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 180 person-rem, with an annual cancer risk of $9.2 \times 10^{-4}$. If this accident occurred, this exposure would result in a total of 0.092 cancer fatalities. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences*: The dose to a maximally exposed individual at the site boundary would be $8.4 \times 10^{-3}$ rem, which would result in an increased likelihood of cancer fatality of $4.2 \times 10^{-6}$. Given an accident probability of 0.01 per year, the cancer risk would be $4.2 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 3.2 person-rem, with an annual cancer risk of $1.6 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of $1.6 \times 10^{-3}$ cancer fatalities. |
| | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 41.1 rems, which would result in an increased likelihood of cancer fatality of $9.9 \times 10^{-4}$. Given an accident probability of $5.0 \times 10^{-8}$ per year, the cancer risk would be $4.9 \times 10^{-11}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.3 \times 10^{5}$ person-rem, with an annual cancer risk of $3.2 \times 10^{-6}$. If this accident occurred, this exposure would result in a total of 63.3 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 71 rems, which would result in an increased likelihood of cancer fatality of $1.8 \times 10^{-3}$. Given an accident probability of $5.0 \times 10^{-8}$ per year, the cancer risk would be $8.9 \times 10^{-11}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.3 \times 10^{4}$ person-rem, with an annual cancer risk of $3.2 \times 10^{-7}$. If this accident occurred, this exposure would result in a total of 6.4 cancer fatalities. |
| | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |

**Radiological and Hazardous Chemical Impacts — Accidents**

| ORR | Pantex | SRS |
|---|---|---|
| • No impact | • No impact | • The dose of 0.045 rem for the beyond design-basis earthquake to a maximally exposed member of the public from a radioactive release accident would result in an increased likelihood of cancer fatality of $1.0 \times 10^{-6}$. The associated risk of cancer fatalities per year is $2.0 \times 10^{-11}$. The dose of 300 person-rem for the beyond design-basis earthquake to a population within 50 miles would result in 0.15 cancer fatalities. The associated risk of cancer fatalities per year is $3.0 \times 10^{-6}$. |
| • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.14 rem, which would result in an increased likelihood of cancer fatality of $6.8 \times 10^{-5}$. Given an accident probability of 0.01 per year, the cancer risk would be $6.8 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.6 \times 10^{3}$ person-rem, with an annual cancer risk of $8.0 \times 10^{-3}$. If this accident occurred, this exposure would result in a total of 0.80 cancer fatalities. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.015 rem, which would result in an increased likelihood of cancer fatality of $7.4 \times 10^{-6}$. Given an accident probability of 0.01 per year, the cancer risk would be $7.4 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 52 person-rem, with an annual cancer risk of $2.6 \times 10^{-4}$. If this accident occurred, this exposure would result in a total of 0.026 cancer fatalities. | • **Tritium Supply and Upgraded Recycling** —*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.046 rem, which would result in an increased likelihood of cancer fatality of $2.3 \times 10^{-5}$. Given an accident probability of 0.01 per year, the cancer risk would be $2.3 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.5 \times 10^{3}$ person-rem, with an annual cancer risk of $7.4 \times 10^{-3}$. If this accident occurred, this exposure would result in a total of 0.74 cancer fatalities. |
| • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be $1.3 \times 10^{3}$ rems, which would result in an increased likelihood of cancer fatality of 0.04. Given an accident probability of $5.0 \times 10^{-8}$ per year, the cancer risk would be $1.8 \times 10^{-9}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.0 \times 10^{6}$ person-rem, with an annual cancer risk of $2.5 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of 504 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 4.3 rems, which would result in an increased likelihood of cancer fatality of 0.01. Given an accident probability of $5.0 \times 10^{-8}$ per year, the cancer risk would be $5.9 \times 10^{-10}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.3 \times 10^{5}$ person-rem, with an annual cancer risk of $3.2 \times 10^{-6}$. If this accident occurred, this exposure would result in a total of 64.4 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 44.5 rems, which would result in an increased likelihood of cancer fatality of $1.2 \times 10^{-3}$. Given an accident probability of $5.0 \times 10^{-8}$ per year, the cancer risk would be $6.1 \times 10^{-11}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.4 \times 10^{5}$ person-rem, with an annual cancer risk of $1.1 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of 222 cancer fatalities. |
| • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **No Tritium Supply Alone.** |

**Radiological and Hazardous Chemical Impacts — Accidents**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.022 rem, which would result in an increased likelihood of cancer fatality of $1.1 \times 10^{-5}$. Given an accident probability of 0.01 per year, the cancer risk would be $1.1 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 200 person-rem, with an annual cancer risk of $1.0 \times 10^{-3}$. If this accident occurred, this exposure would result in a total of 0.10 cancer fatalities. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be $9.1 \times 10^{-3}$ rems, which would result in an increased likelihood of cancer fatality of $4.6 \times 10^{-6}$. Given an accident probability of 0.01 per year, the cancer risk would be $4.6 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 3.4 person-rem, with an annual cancer risk of $1.7 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of $1.7 \times 10^{-3}$ cancer fatalities. |
| | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be $7.8 \times 10^{-2}$ rem, which would result in an increased likelihood of cancer fatality of $1.8 \times 10^{-6}$. Given an accident probability of $6.0 \times 10^{-8}$ per year, the cancer risk would be $1.9 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 226 person-rem, with an annual cancer risk of $6.8 \times 10^{-9}$. If this accident occurred, this exposure would result in a total of 0.11 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 0.14 rems, which would result in an increased likelihood of cancer fatality of $3.3 \times 10^{-6}$. Given an accident probability of $6.0 \times 10^{-8}$ per year, the cancer risk would be $2.0 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 22.7 person-rem, with an annual cancer risk of $6.8 \times 10^{-10}$. If this accident occurred, this exposure would result in a total of 0.011 cancer fatalities. |
| | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |
| | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |

**Radiological and Hazardous Chemical Impacts — Accidents**

| ORR | Pantex | SRS |
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| • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | |
| • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.18 rem, which would result in an increased likelihood of cancer fatality $9.2 \times 10^{-5}$. Given an accident probability of 0.01 per year, the cancer risk would be $9.2 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $2.0 \times 10^{3}$ person-rem, with an annual cancer risk of 0.01. If this accident occurred, this exposure would result in a total of 1.0 cancer fatalities. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.016 rem, which would result in an increased likelihood of cancer fatality of $8.1 \times 10^{-6}$. Given an accident probability of 0.01 per year, the cancer risk would be $8.1 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 68 person-rem, with an annual cancer risk of $3.4 \times 10^{-4}$. If this accident occurred, this exposure would result in a total of 0.034 cancer fatalities. | • **Tritium Supply and Upgraded Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 0.059 rem, which would result in an increased likelihood of cancer fatality of $3.0 \times 10^{-5}$. Given an accident probability of 0.01 per year, the cancer risk would be $3.0 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $2.0 \times 10^{3}$ person-rem, with an annual cancer risk of 0.01. If this accident occurred, this exposure would result in a total of 1.0 cancer fatalities. |
| • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 2.5 rems, which would result in an increased likelihood of cancer fatality of $6.8 \times 10^{-5}$. Given an accident probability of $6.0 \times 10^{-8}$ per year, the cancer risk would be $4.1 \times 10^{-12}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.9 \times 10^{3}$ person-rem, with an annual cancer risk of $5.5 \times 10^{-8}$. If this accident occurred, this exposure would result in a total of 0.92 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 0.82 rems, which would result in an increased likelihood of cancer fatality of $2.2 \times 10^{-5}$. Given an accident probability of $6.0 \times 10^{-8}$ per year, the cancer risk would be $1.3 \times 10^{-12}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 236 person-rem, with an annual cancer risk of $7.1 \times 10^{-9}$. If this accident occurred, this exposure would result in a total of 0.12 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be $8.3 \times 10^{-2}$ rems, which would result in an increased likelihood of cancer fatality of $2.3 \times 10^{-6}$. Given an accident probability of $6.0 \times 10^{-8}$ per year, the cancer risk would be $1.4 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 800 person-rem, with an annual cancer risk of $2.4 \times 10^{-8}$. If this accident occurred, this exposure would result in a total of 0.40 cancer fatalities. |
| • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **No Tritium Supply Alone.** |
| • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | |

**Radiological and Hazardous Chemical Impacts — Accidents**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor** | • **Collocated Supply and Recycling—** *Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 5.1 and 0.23 rems for the Large and Small ALWRs, respectively, which would result in an increased likelihood of cancer fatality $2.5 \times 10^{-3}$ and $1.1 \times 10^{-4}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk to the maximally exposed individual would be $2.5 \times 10^{-6}$ and $1.1 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.5 \times 10^{4}$ and $2.1 \times 10^{3}$ person-rem, with an annual cancer risk of 0.023 and $1.1 \times 10^{-3}$. If this accident occurred, this exposure would result in a total of 23 and 1.1 cancer fatalities. | • **Collocated Supply and Recycling—** *Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 2.3 and 0.098 rems for the Large and Small ALWRs, respectively, which would result in an increased likelihood of cancer fatality $1.1 \times 10^{-3}$ and $4.9 \times 10^{-5}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk to the maximally exposed individual would be $1.1 \times 10^{-6}$ and $4.9 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 830 and 37 person-rem, with an annual cancer risk of $4.1 \times 10^{-4}$ and $1.8 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of 0.41 and 0.018 cancer fatalities. |
| | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 166 and 149 rems for the Large and Small ALWRs, respectively, which would result in an increased likelihood of cancer fatality $3.7 \times 10^{-3}$ and $4.3 \times 10^{-3}$. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $7.4 \times 10^{-11}$ and $8.6 \times 10^{-11}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.6 \times 10^{5}$ and $5.7 \times 10^{5}$ person-rem, with an annual cancer risk of 0.007 and 0.007. If this accident occurred, this exposure would result in a total of 229 and 282 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 284 and 266 rems for the Large and Small ALWRs, respectively, which would result in $6.7 \times 10^{-3}$ and $7.7 \times 10^{-3}$ cancer fatalities. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $1.3 \times 10^{-10}$ and $1.5 \times 10^{-10}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.6 \times 10^{4}$ and $5.7 \times 10^{4}$ person-rem, with an annual cancer risk of $4.6 \times 10^{-7}$ and $5.7 \times 10^{-7}$. If this accident occurred, this exposure would result in a total of 23 and 28.4 cancer fatalities. |
| | • **Tritium Supply Alone—***Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone—***Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |
| | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |

**Radiological and Hazardous Chemical Impacts — Accidents**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 44 and 1.9 rems for the Large and Small ALWRs, respectively, which would result in an increased likelihood of cancer fatality of $4.4 \times 10^{-2}$ and $9.7 \times 10^{-4}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $4.4 \times 10^{-5}$ and $9.7 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.9 \times 10^{4}$ and $2.2 \times 10^{5}$ person-rem, with an annual cancer risk of 0.24 and 0.011. If this accident occurred, this exposure would result in a total of 240 and 11 cancer fatalities. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 3.9 and 0.18 rems for the Large and Small ALWRs, respectively, which would result in an increased likelihood of cancer fatality of $2.0 \times 10^{-3}$ and $8.9 \times 10^{-5}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $2.0 \times 10^{-6}$ and $8.9 \times 10^{-8}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.6 \times 10^{4}$ and 730 person-rem, with an annual cancer risk of $8.0 \times 10^{-3}$ and $3.6 \times 10^{-4}$. If this accident occurred, this exposure would result in a total of 8.0 and 0.36 cancer fatalities. | • **Tritium Supply and Upgraded Recycling**—*Low to Moderate Consequences:* The dose to a maximally exposed individual at the site boundary would be 14 and 0.64 rems for the Large and Small ALWRs, respectively, which would result in an increased likelihood of cancer fatality of $7.1 \times 10^{-3}$ and $3.2 \times 10^{-4}$. Given an accident probability of $1.0 \times 10^{-3}$ per year, the cancer risk would be $7.1 \times 10^{-6}$ and $3.2 \times 10^{-7}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.6 \times 10^{5}$ and $2.1 \times 10^{4}$ person-rem, with an annual cancer risk of 0.23 and 0.011. If this accident occurred, this exposure would result in a total of 230 and 11 cancer fatalities. |
| • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be $5.1 \times 10^{3}$ and $5.3 \times 10^{3}$ rems for the Large amd Small ALWRs respectively, which would result in 0.13 and 0.16 cancer fatalities. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $2.6 \times 10^{-9}$ and $3.2 \times 10^{-9}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $3.7 \times 10^{6}$ and $4.4 \times 10^{6}$ person-rem, with an annual cancer risk of $3.7 \times 10^{-5}$ and $4.5 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of 1860 and 2230 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be $1.7 \times 10^{3}$ and $1.7 \times 10^{3}$ rems for the Large and Small ALWRs, respectively, which would result in 0.04 and 0.05 cancer fatalities. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $8.7 \times 10^{-10}$ and $1.0 \times 10^{-9}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $4.8 \times 10^{5}$ and $5.7 \times 10^{5}$ person-rem, with an annual cancer risk of $4.8 \times 10^{-6}$ and $5.7 \times 10^{-6}$. If this accident occurred, this exposure would result in a total of 238 and 283 cancer fatalities. | • *High Consequence/Low Probability*–The dose to a maximally exposed individual at the site boundary would be 174 and 174 rems for the Large and Small ALWRs, respectively, which would result in $4.6 \times 10^{-3}$ and $5.3 \times 10^{-3}$ cancer fatalities. Given an accident probability of $2.0 \times 10^{-8}$ per year, the cancer risk would be $9.1 \times 10^{-11}$ and $1.1 \times 10^{-10}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.6 \times 10^{6}$ and $2.0 \times 10^{6}$ person-rem, with an annual cancer risk of $1.6 \times 10^{-5}$ and $2.0 \times 10^{-5}$. If this accident occurred, this exposure would result in a total of 808 and 984 cancer fatalities. |
| • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **No Tritium Supply Alone.** |
| • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | |

**Radiological and Hazardous Chemical Impacts — Accidents**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences (Helium -3 Target)*: The consequences of an APT accident are nil. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences (Helium-3 Target):* The consequences of an APT accident are nil. |
| | • *Low to Moderate Consequences (SILC Target)*—The consequences of an APT accident are nil. | • Low to Moderate Consequences (*SILC Target)*—The consequences of an APT accident are nil. |
| | • *High Consequence/Low Probability (Helium -3 Target)*—The dose to a maximally exposed individual at the site boundary would be $1.3 \times 10^{-5}$ rem, which would result in an increased likelihood of cancer fatality of $1.9 \times 10^{-10}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $1.9 \times 10^{-14}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.018 person-rem, with an annual cancer risk of $9.0 \times 10^{-10}$. If this accident occurred, this exposure would result in a total of $9.0 \times 10^{-6}$ cancer fatalities. | • *High Consequence/Low Probability (Helium -3 Target)*—The dose to a maximally exposed individual at the site boundary would be $3.5 \times 10^{-5}$ rem, which would result in an increased likelihood of cancer fatality of $6.0 \times 10^{-10}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $6.0 \times 10^{-14}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at $1.8 \times 10^{-3}$ person-rem, with an annual cancer risk of $9.0 \times 10^{-11}$. If this accident occurred, this exposure would result in a total of $9.0 \times 10^{-7}$ cancer fatalities. |
| | • *High Consequence/Low Probability (SILC Target)*—The dose to a maximally exposed individual at the site boundary would be $1.6 \times 10^{-4}$ rem, which would result in an increased likelihood of cancer fatality of $1.5 \times 10^{-9}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $1.5 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.10 person-rem, with an annual cancer risk of $5.0 \times 10^{-9}$. If this accident occurs, this exposure would result in a total of $5.0 \times 10^{-5}$ cancer fatalities. | • *High Consequence/Low Probability (SILC Target)*—The dose to a maximally exposed individual at the site boundary would be $4.0 \times 10^{-4}$ rem, which would result in an increased likelihood of cancer fatality of $4.5 \times 10^{-9}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $4.5 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.011 person-rem, with an annual cancer risk of $5.5 \times 10^{-6}$. If this accident occurs, this exposure would result in a total of $5.5 \times 10^{-6}$ cancer fatalities. |
| | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |
| | • *High Consequences/Low Probability:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. |

**Radiological and Hazardous Chemical Impacts — Accidents**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences (Helium -3 Target)*: The consequences of an APT accident are nil. | • **Collocated Tritium Supply and Recycling**—*Low to Moderate Consequences (Helium -3 Target)*: The consequences of an APT accident are nil. | • **Tritium Supply and Upgraded Recycling**—*Low to Moderate Consequences (Helium -3 Target)*: The consequences of an APT accident are nil. |
| • *Low to Moderate Consequences (SILC Target)*—The consequences of an APT accident are nil. | • *Low to Moderate Consequences (SILC Target)*—The consequences of an APT accident are nil. | • *Low to Moderate Consequences (SILC Target)*—The consequences of an APT accident are nil. |
| • *High Consequence/Low Probability (Helium -3 Target)*–The dose to a maximally exposed individual at the site boundary would be $2.6 \times 10^{-4}$ rem, which would result in an increased likelihood of cancer fatality of $5.5 \times 10^{-9}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $5.5 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.18 person-rem, with an annual cancer risk of $9.0 \times 10^{-9}$. If this accident occurred, this exposure would result in a total of $9.0 \times 10^{-5}$ cancer fatalities. | • *High Consequence/Low Probability (Helium -3 Target)*–The dose to a maximally exposed individual at the site boundary would be $1.7 \times 10^{-4}$ rem, which would result in an increased likelihood of cnacer fatality of $3.5 \times 10^{-9}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $3.5 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.022 (person-rem), with an annual cancer risk of $1.1 \times 10^{-9}$. If this accident occurred, this exposure would result in a total of $1.1 \times 10^{-5}$ cancer fatalities. | • *High Consequence/Low Probability (Helium -3 Target)*–The dose to a maximally exposed individual at the site boundary would be $1.1 \times 10^{-5}$ rem, which would result in an increased likelihood of cancer fatality of $2.3 \times 10^{-10}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $2.3 \times 10^{-14}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.068 person-rem, with an annual cancer risk of $3.4 \times 10^{-9}$. This exposure would result in a total of $3.4 \times 10^{-5}$ cancer fatalities. |
| • *High Consequence/Low Probability (SILC Target)*–The dose to a maximally exposed individual at the site boundary would be $2.6 \times 10^{-3}$ rem, which would result in an increased likelihood of cancer fatality of $4.1 \times 10^{-8}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $4.1 \times 10^{-12}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.12 person-rem, with an annual cancer risk of $6.0 \times 10^{-9}$. If this accident occurred, this exposure would result in a total of $6.0 \times 10^{-5}$ cancer fatalities. | • *High Consequence/Low Probability (SILC Target)*—The dose to a maximally exposed individual at the site boundary would be $1.6 \times 10^{-3}$ rem, which would result in an increased likelihood of cancer fatality of $2.6 \times 10^{-8}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $2.6 \times 10^{-12}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.15 (person-rem), with an annual cancer risk of $7.5 \times 10^{-9}$. If this accident occurred, this exposure would result in a total of $7.5 \times 10^{-5}$ cancer fatalities. | • *High Consequence/Low Probability (SILC Target)*–The dose to a maximally exposed individual at the site boundary would be $1.2 \times 10^{-4}$ rem, which would result in an increased likelihood of cancer fatality of $1.7 \times 10^{-9}$. Given an accident probability of $1.0 \times 10^{-4}$ per year, the cancer risk would be $1.7 \times 10^{-13}$ per year. For the population residing within 50 miles of the accident, the dose is estimated at 0.43 person-rem, with an annual cancer risk of $2.2 \times 10^{-8}$. If this accident occurred, this exposure would result in a total of $2.2 \times 10^{-4}$ cancer fatalities. |
| • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **Tritium Supply Alone**—*Low to Moderate Consequences:* The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • **No tritium Supply Alone.** |
| • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | • *High Consequences/Low Probability*–The accident impacts from the recycling and extraction facilities are negligible compared to those from the supply technologies. Therefore, the impacts from supply technologies alone are identical to those listed above. | |

**Radiological and Hazardous Chemical Impacts — Accidents**

| Technology | INEL | NTS |
|---|---|---|
| **All Supply Technologies** | • **Less Than Baseline**—The accident impacts for any of the supply technologies operating at reduced production capacity would not differ from the impacts associated with technologies operating at full capacity. | • **Less Than Baseline**—The accident impacts for any of the supply technologies operating at reduced production capacity would not differ from the impacts associated with technologies operating at full capacity |
| | • **Tritium Extraction and Recycling Phaseout**—The phaseout of recycling at SRS would eliminate any accident impacts associated with that facility. This action applies to any collocated tritium and new recycling facility at INEL. | • **Tritium Extraction and Recycling Phaseout**—The phaseout of recycling at SRS would eliminate any accident impacts associated with that facility. This action applies to any collocated tritium and new recycling facility at NTS. |
| **Waste Management** | | |
| **No Action (2010)** | • INEL would continue to manage spent nuclear fuel and the following waste types: high-level; TRU; low-level; mixed TRU and low-level; hazardous; and nonhazardous. | • NTS would continue to manage the following waste types: TRU; low-level; mixed TRU and low-level; hazardous; and nonhazardous. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. |
| | • Liquid LLW would be generated. The existing treatment facility may be adequate. Solid LLW generation would increase by 109 percent requiring 15 acres/year of onsite LLW disposal area. | • Liquid LLW would be generated. A new treatment facility would be required. Solid LLW generation would increase by 13 percent requiring 13.5 acres/year of onsite LLW disposal area. |
| | • Liquid mixed LLW would be generated at such a small quantity that no impact would occur. Solid mixed LLW generation would increase by 19 percent. New or expanded treatment and storage facilities may be required. | • Liquid mixed LLW would be generated and require additional treatment capability for organic mixed waste. Solid mixed LLW generation would increase by 2 percent. Additional treatment capability for organic mixed waste may be required. |
| | • Hazardous waste generation would increase by 13 percent. Use of existing facilities is feasible. | • Hazardous waste generation would increase by 205 percent and require an additional storage facility. |
| | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 22 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 214 percent. Landfill life reduced or expansion required. |
| | • Other solid nonhazardous wastes are recycled. No impacts would occur. | • Other solid nonhazardous wastes are recycled. No impacts would occur. |

**Radiological and Hazardous Chemical Impacts — Accidents**

| ORR | Pantex | SRS |
|---|---|---|
| • **Less Than Baseline**—The accident impacts for any of the supply technologies operating at reduced production capacity would not differ from the impacts associated with technologies operating at full capacity. | • **Less Than Baseline**—The accident impacts for any of the supply technologies operating at reduced production capacity would not differ from the impacts associated with technologies operating at full capacity. | • **Less Than Baseline**—The accident impacts for any of the supply technologies operating at reduced production capacity would not differ from the impacts associated with technologies operating at full capacity. |
| • **Tritium Extraction and Recycling Phaseout**—The phaseout of recycling at SRS would eliminate any accident impacts associated with that facility. This action applies to any collocated tritium and new recycling facility at ORR. | • **Tritium Extraction and Recycling Phaseout**—The phaseout of recycling at SRS would eliminate any accident impacts associated with that facility. This action applies to any collocated tritium and new recycling facility at Pantex. | • **No Tritium Extraction and Recycling Phaseout With SRS Alternatives.** |
| **Waste Management** | | |
| • ORR would continue to manage spent nuclear fuel and the following waste types: TRU; low-level; mixed TRU and low-level; hazardous; and nonhazardous. | • Pantex would continue to manage the following waste types: low-level; mixed low-level; hazardous; and nonhazardous. | • SRS would continue to manage spent nuclear fuel and the following waste types: high-level; TRU; low-level; mixed TRU and low-level; hazardous; and nonhazardous. |
| • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. | • **Tritium Supply and Upgraded Recycling**—Spent nuclear fuel would be generated and require a new storage facility. |
| • Liquid LLW generation would increase by 358 percent and require a new treatment facility. Solid LLW generation would increase by 60 percent requiring 3.5 acres/year of onsite LLW disposal area. | • Liquid LLW generation would increase by 525,000 percent and require a new treatment facility. Solid LLW generation would increase by 22,200 percent requiring a new staging facility and 92 LLW shipment to NTS. | • Liquid LLW would be generated and require a new treatment facility. Solid LLW generation would increase by 102 percent and require 12 acres/year of onsite LLW disposal area. |
| • Liquid mixed LLW generation would increase less than 1 percent. Solid mixed LLW would increase by 1 percent. No impacts would occur. | • Liquid mixed LLW generation would increase 1 percent. Solid mixed LLW generation would increase by 2,440 percent and require the expansion of the existing and planned treatment and storage facilities. | • No increase in liquid mixed LLW generation. Solid mixed LLW generation would increase by 79 percent and require additional facilities. |
| • Hazardous waste generation would increase by 4 percent. Negligible impacts to existing facilities. | • Hazardous waste generation would increase by 65 percent. Existing/planned facilities are adequate. | • Hazardous waste generation would increase by 308 percent and require additional storage facilities. |
| • Liquid nonhazardous sanitary waste generation would increase by 511 percent and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 19 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste generation would increase by 156 percent and require expansion of or new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 2,040 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste generation would increase by 1,260 percent and require additional treatment facilities. Solid nonhazardous sanitary waste generation would increase by 10 percent. Landfill life reduced or expansion required. |
| • Other solid nonhazardous wastes are recycled. No impacts would occur. | • Other solid nonhazardous waste are recycled. No impacts would occur. | • Other solid nonhazardous waste are recycled. No impacts would occur. |

**Waste Management**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous waste. Required LLW disposal area decreases to 14 acres per year. Solid sanitary generation decreases to 22 percent to 11 percent increase; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other nonhazardous solid waste. Required LLW disposal area decreases to 12.5 acres per year. Solid sanitary generation decreases to a 214 percent to a 109 percent increase; thus, proportionately decreasing impact landfill. |
| | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. |
| | • Liquid LLW would be generated. Existing treatment facility may be adequate. Solid LLW generation would increase by 32 percent and require 4 acres per year of onsite LLW disposal area. | • Liquid LLW would be generated and require a new treatment facility. Solid LLW generation would increase by 4 percent require 4 acres per year of onsite LLW disposal area. |
| | • Liquid mixed LLW would be generated at such a small quantity that no impact would occur. Solid mixed LLW generation would increase by less than 1 percent. Negligible impacts to existing facilities. | • Liquid mixed LLW would be generated and require additional treatment capability for organic mixed waste. Solid mixed LLW generation would increase by less than 1 percent. Additional treatment capacility for organic mixed waste may be required. |
| | • Hazardous waste generation would increase by 33 percent and use of existing facilities is feasible. | • Hazardous waste generation would increase by 505 percent and require an additional storage facility. |
| | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 22 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 211 percent. Landfill life reduced or expansion required. |
| | • Other solid nonhazardous waste are recycled. No impacts would occur. | • Other solid nonhazardous waste are recycled. No impacts would occur. |

**Waste Management**

| ORR | Pantex | SRS |
|---|---|---|
| • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous waste. Required LLW disposal area decreased to 3.3 acres per year. Solid sanitary generation decreases to a 19 percent to a 10 percent increase; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous waste. LLW shipments to NTS decrease to 86. Solid sanitary generation decreases to a 2,050 to a 2,040 percent increase; thus, proportionately decreasing impact to landfill. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—No appreciable change from collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from collocated supply and recycling. |
| • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated and require a new storage facility. | • **Tritium Supply and Upgraded Recycling**—Spent nuclear fuel would be generated require and a new storage facility. |
| • Liquid LLW generation would increase by 89 percent and require a new treatment facility. Solid LLW generation would increase by 18 percent requiring 1 acre per year of onsite LLW disposal area. | • Liquid LLW generation would increase by 131,000 percent and require a new treatment facility. Solid LLW generation would increase by 6,600 percent, require a new staging facility, and 27 LLW shipment to NTS. | • Liquid LLW would be generated and require a new treatment facility. Solid LLW generation would increase by 25 percent requiring 3 acres per year of onsite LLW disposal area. |
| • Liquid and solid mixed LLW waste generation would increase by less than 1 percent. No impacts would occur. | • Liquid mixed LLW would be generated in such small quantities that only minor impacts would occur. Solid mixed LLW generation would increase by 60 percent. Existing/planned facilities would be adequate. | • Liquid and solid mixed LLW generation would increase by less than 1 percent. No impacts would occur. |
| • Hazardous waste generation would increase by 9 percent. Negligible impacts to existing facilities. | • Hazardous waste generation would increase by 160 percent. Negligible impacts to existing facilities. | • Hazardous waste generation would increase by 769 percent and require additional storage facilities. |
| • Liquid nonhazardous sanitary waste generation would increase by 342 percent and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 19 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste generation would increase by 111 percent and require expansion of or new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 2,020 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste generation would increase by 877 percent and require additional treatment facilities. Solid nonhazardous sanitary waste generation would increase by 9 percent. Landfill life reduced or expansion required. |
| • Other solid nonhazardous wastes are recycled. No impacts would occur. | • Other solid nonhazardous wastes are recycled. No impacts would occur. | • Other solid nonhazardous wastes are recycled. No impacts would occur. |

**Waste Management**

| Technology | INEL | NTS |
|---|---|---|
| **Modular High Temperature Gas-Cooled Reactor (Continued)** | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 3 acres per year. Solid sanitary generation decreases to a 22 percent to an 11 percent increase; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 3 acres per year. Solid sanitary generation decreases to a 211 percent to a 106 percent increase; thus, proportionately decreasing impact to landfill. |
| | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. |
| **Advanced Light Water Reactor** | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated by both the Large and Small ALWRs and require a new storage facility. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated by both the Large and Small ALWRs and require a new storage facility. |
| | • Liquid LLW would be generated. The large ALWR would require a new treatment facility while the existing treatment facility may be adequate for the small. Solid LLW generation would increase by 21 and 20 percent for the Large and Small ALWR, and requiring 5 and 3 acres per year of onsite LLW disposal area, respectively. | • Liquid LLW would be generated and both the Large and Small ALWRs would require a separate treatment facility. Solid LLW generation would increase by 3 and 2 percent for the Large and Small ALWR, and requiring 4.5 and 2.5 acres per year of onsite LLW disposal area, respectively. |
| | • Liquid mixed LLW would be generated at such a small quantity that negligible impacts would occur for either ALWR. Solid mixed LLW generation would increase by 1 percent for either. | • Liquid mixed LLW would be generated and both the Large and Small ALWRs would require an additional treatment capability for organic mixed waste. Solid mixed LLW generation would increase by less than 1 percent for either. Additional treatment capability for organic mixed waste may be required. |
| | • Hazardous waste generation would increase by 12 percent for the Large and Small ALWR. Use of existing facilities is feasible. | • Hazardous waste generation would increase by 180 percent for either the Large or Small ALWR. An additional storage facility would be required for either. |
| | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities for either ALWR. Solid nonhazardous sanitary waste generation would increase by 21 and 17 percent for the Large and Small ALWRs. Landfill life reduced or expansion required by either. | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities for either ALWR. Solid nonhazardous sanitary waste generation would increase by 204 and 166 percent for the Large and Small ALWRs. Landfill life reduced or expansion required by either. |

**Waste Management**

| ORR | Pantex | SRS |
|---|---|---|
| • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 0.8 acres per year. Solid sanitary generation decreases to a 19 percent to a 10 percent increase; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. LLW shipments to NTS decrease to 22. Solid sanitary generation decreases to a 2,020 to a 1,010 percent increase; thus proportionately decreasing impact to landfill. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. |
| • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated by both the Large and Small ALWRs and require a new storage facility. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would be generated by both the Large and Small ALWRs and require a new storage facility. | • **Tritium Supply and Upgraded Recycling**—Spent nuclear fuel would be generated by both the Large and Small ALWRs and require a new storage facility. |
| • Liquid LLW generation would increase by 852 and 135 percent for the Large and Small ALWR, and a new treatment facility would be required for either. Solid LLW generation would increase by approximately 11 percent, requiring 1.2 and 0.7 acres per year of onsite LLW disposal area, respectively. | • Liquid LLW generation would increase by 1,250,000 and 198,000 percent for the Large and Small ALWR, and a new treatment facility would be required for either. Solid LLW generation would increase by 4,240 and 4,040 percent for the Large and Small ALWRs, respectively, a new staging facility would be required for either, and 32 and 18 LLW shipments to NTS, respectively. | • Liquid LLW would be generated for the Large and Small ALWR, and a separate treatment facility would be required for either. Solid LLW generation would increase by 14 and 13 percent respectively, and require 3.5 and 2 acres/year of onsite LLW disposal area. |
| • Liquid and solid mixed LLW generation would increase by less than 1 percent. No impacts would occur for either ALWR. | • Liquid mixed LLW would be generated at such a small quantity that negligible impacts would occur for either ALWR. Solid mixed LLW generation would increase 160 percent. Existing/planned facilities would be adequate. | • No increasing liquid mixed LLW generation for either the Large or Small ALWR. Solid mixed LLW generation would increase by 4 percent for either. Expansion of existing/planned treatment capacity may be required. |
| • Hazardous waste generation would increase by 3 percent for the Large and Small ALWR. Negligible impacts to existing facilities. | • Hazardous waste generation would increase by 57 percent for the Large and Small ALWR. Negligible impacts to existing facilities. | • Hazardous waste generation would increase by 269 percent for the Large and Small ALWRs. Additional storage facilities would be required. |
| • Liquid nonhazardous sanitary waste generation would increase by 1,310 and 594 percent for the Large and Small ALWRs and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 19 and 15 percent for the Large and Small ALWRs. Landfill life reduced or expansion by either. | • Liquid nonhazardous sanitary waste generation would increase by 261 and 161 percent for the Large and Small ALWRs, and either would require expansion of or new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 1,950 and 1,580 percent for the Large and Small ALWRs. Landfill life by either reduced or expansion required by either. | • Liquid nonhazardous sanitary waste generation would increase by 3,380 and 1,530 percent for the Large and Small ALWRs, and either would require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 9 and 5 percent for the Large and Small ALWRs. Landfill life reduced or expansion required by either. |

**Waste Management**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor (continued)** | • Other solid nonhazardous wastes would be recycled. No impacts would occur. | • Other solid nonhazardous wastes would be recycled. No impacts would occur. |
| | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 4 and 2 acres per year, respectively. Solid sanitary generation decreases to a 10 and 6 percent increase, respectively; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 3.5 and 1.5 acres per year, respectively. Solid sanitary generation decreases to a 99 and 60 percent increase, respectively; thus, proportionately decreasing impact to landfill. |
| | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and upgraded recycling. |
| **Accelerator Production of Tritium** | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would not be generated | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would not be generated. |
| | • No increase in liquid LLW is expected. Solid LLW generation would increase by 18 percent requiring 3 acres of onsite LLW disposal area. | • No increase in liquid LLW is expected. Solid LLW generation would increase by 2 percent requiring 2.5 acres of onsite LLW disposal area. |
| | • Liquid mixed LLW would be generated. Solid mixed LLW generation would increase by 1 percent. Minor impacts would occur. | • Liquid mixed LLW would be generated and require an additional treatment capability for organic mixed waste. Solid mixed LLW generation would increase by less than 1 percent. Additional treatment capability for organic mixed waste may be required. |
| | • Hazardous waste generation would increase by 1 percent. Use of existing facilities is feasible. | • Hazardous waste generation would increase by 18 percent and the existing storage facilities would require expansion. |
| | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 13 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste would be generated and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 123 percent. Landfill life reduced or expansion required. |
| | • Other solid nonhazardous wastes would be recycled. No impacts would occur. | • Other solid nonhazardous wastes would be recycled. No impacts would occur. |

**Waste Management**

| ORR | Pantex | SRS |
|---|---|---|
| • Other solid nonhazardous wastes would by recycled. No impacts would occur. | • Other solid nonhazardous wastes would by recycled. No impacts would occur. | • Other solid nonhazardous wastes would by recycled. No impacts would occur. |
| • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 1 and 0.5 acres per year, respectively. Solid sanitary generation decreases to a 9 and 5 percent increase, respectively; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—No change for spent nuclear fuel or liquid LLW. Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. LLW shipments would decrease to 26 and 13, respectively. Solid sanitary generation decreases to a 940 and 572 percent increase respectively; thus, proportionately decreasing impact to the landfill. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. |
| • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would not be generated. | • **Collocated Tritium Supply and Recycling**—Spent nuclear fuel would not be generated. | • **Tritium Supply and Upgraded Recycling**—Spent nuclear fuel would not be generated. |
| • No increase in liquid LLW is expected. Solid LLW generation would increase by 10 percent requiring 0.6 acres per year of onsite LLW disposal area. | • No increase in liquid LLW is expected. Solid LLW generation would increase by 3,580 percent require a new staging facility, and 16 LLW shipments to NTS. | • No increases in liquid LLW is expected. Solid LLW generation would increase by 11 percent requiring 1 acres per year of onsite LLW disposal area. |
| • Liquid and solid mixed LLW generation would increase by less than 1 percent. Negligible impacts to existing facilities. | • Liquid mixed LLW would be generated in such small quantities that no impacts would occur. Solid mixed LLW generation would increase by 176 percent. Existing/planned facilities would be adequate. | • No increase in liquid mixed LLW generation. Solid mixed LLW generation would increase by 5 percent requiring expansion of treatment facilities. |
| • Hazardous waste generation would increase by less than 1 percent but only minor impacts would occur. | • Hazardous waste generation would increase by 6 percent. Negligible impacts to existing facilities. | • Hazardous waste generation would increase by 19 percent and require expansion of storage facilities. |
| • Liquid nonhazardous sanitary waste generation would increase by 92 percent and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 11 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste generation would increase by 1,040 percent and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by 1,180 percent. Landfill life reduced or expansion required. | • Liquid nonhazardous sanitary waste generation would increase by 216 percent and require new treatment facilities. Solid nonhazardous sanitary waste generation would increase by less than 2 percent. Negligible impact to landfill life. |
| • Other solid nonhazardous wastes would be recycled. No impacts would occur. | • Other solid nonhazardous wastes would be recycled. No impacts would occur. | • Other solid nonhazardous wastes would be recycled. No impacts would occur. |

**Waste Management**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium** | • **Tritium Supply Alone**—Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 2 acres per year. Solid sanitary generation decreases from 12 percent to a less than 1 percent increase; thus, only a small impact to the landfill. | • **Tritium Supply Alone**—Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous wastes. Required LLW disposal area decreases to 1.5 acres per year. Solid sanitary generation decreases from 123 percent to 18 percent increase; thus, proportionately decreasing impact to landfill. |
| | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. |
| **All Supply Technologies** | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at INEL. Decrease the generation of solid low-level, mixed low-level, hazardous, and sanitary wastes. The 7 percent decrease in solid LLW generation would extend life of LLW disposal facility. Offsite hazardous wastes shipments to offsite RCRA facilities would decrease. Decrease in sanitary wastes would occur over time as recycling facilities are transitioned. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at NTS. Decrease the generation of solid low-level, mixed low-level, hazardous, and sanitary wastes. The 7 percent decrease in solid LLW generation would extend life of LLW disposal facility. Offsite hazardous wastes shipments to offsite RCRA facilities would decrease. Decrease in sanitary wastes would occur over time as recycling facilities are transitioned. |
| **Intersite Transport of Weapons Complex Materials** | | |
| **No Action (2010)** | • Negligible tritium transport. | • Negligible tritium transport. |
| **Heavy Water Reactor** | • **Collocated Tritium Supply and Recycling**— The relative transportation risk of tritium for this alternative is 0.71 compared to No Action. | • **Collocated Tritium Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.70 compared to No Action. |
| | • The potential risk for transporting heavy water is $3.57 \times 10^{-5}$ cancer fatalities. | • The potential risk for transporting heavy water is $3.57 \times 10^{-5}$ cancer fatalities. |
| | • No intersite transport of LLW. | • No intersite transport of LLW. |

**Waste Management**

| ORR | Pantex | SRS |
|---|---|---|
| • **Tritium Supply Alone**—Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous waste. Required LLW disposal area decreases to 0.4 acres per year. Solid sanitary generation decreases from 11 percent to a less than 2 percent increase; thus, proportionately decreasing impact to landfill. | • **Tritium Supply Alone**—Liquid mixed LLW no longer generated. Generation decreases however impacts do not change for solid mixed low-level, hazardous, liquid sanitary, and other solid nonhazardous waste. LLW shipment would decrease to 10. Solid sanitary generation decreases from a 1,180 to a 169 percent increase, thus, proportionately decreasing impact to the landfill. | • **No Tritium Supply Alone.** |
| • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. | • **Less Than Baseline Operations**—No appreciable change from the collocated supply and recycling. |
| • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at ORR. Decrease the generation of solid low-level, mixed low-level, hazardous, and sanitary wastes. The 7 percent decrease in solid LLW generation would extend life of LLW disposal facility. Offsite hazardous wastes shipments to offsite RCRA facilities would decrease. Decrease in sanitary wastes would occur over time as recycling facilities are transitioned. | • **Tritium Recycling Phaseout**—This action applies to any collocated tritium supply and new recycling facility at Pantex. Decrease the generation of solid low-level, mixed low-level, hazardous, and sanitary wastes. The 7 percent decrease in solid LLW generation would extend life of LLW disposal facility. Offsite hazardous wastes shipments to offsite RCRA facilities would decrease. Decrease in sanitary wastes would occur over time as recycling facilities are transitioned. | • **No Tritium Recycling Phaseout With SRS Alternatives.** |
| **Intersite Transport of Weapons Complex Materials** | | |
| • Negligible tritium transport. | • The risk of transporting limited-life components to and from Pantex is negligible under normal operations. Under accident conditions, the risk of transporting limited-life components to and from Pantex would be $1.0 \times 10^{-8}$ cancer fatalities per year from radiological affects. | • The risk of transporting limited-life components to and from SRS is negligible under normal operation. Under accident conditions, the risk of transporting limited-life components to and from SRS would be $1.0 \times 10^{-8}$ cancer facilities per year from radiological affects. |
| • **Collocated Tritium Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.87 compared to No Action. | • **Collocated Tritium Supply and Recycling**—The risk is zero because there is no intersite transportation of tritium when tritium supply and recycling are collocated with the assembly and disassembly function. | • **Tritium Supply and Upgraded Recycling**—The transportation risk of tritium for this alternative is the same as No Action. |
| • The potential risk for transporting heavy water is $3.57 \times 10^{-5}$ cancer fatalities. | • The potential risk for transporting heavy water is $3.57 \times 10^{-5}$ cancer fatalities. | • No transport of heavy water, thus no risk. |
| • No intersite transport of LLW. | • For intersite transportation of low-level waste, credible accidents associated with locating an HWR at Pantex would result in risks of $2.99 \times 10^{-8}$ fatal cancers per year from radiological releases and $3.96 \times 10^{-4}$ fatalities per year from nonradiological causes. | • No intersite transport of LLW. |

**Intersite Transport of Weapons Complex Materials**

| Technology | INEL | NTS |
|---|---|---|
| **Heavy Water Reactor (Continued)** | • **Supply Alone**—The risk for transporting new tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS.<br>• The potential risk for transporting heavy water is $1.4 \times 10^{-5}$ cancer fatalities.<br>• No intersite transport of LLW. | • **Supply Alone**—The risk for transporting new tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS.<br>• The potential risk for transporting heavy water is $1.4 \times 10^{-5}$ cancer fatalities.<br>• No intersite transport of LLW. |
| **Modular High Temperature Gas-Cooled Reactor** | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations.<br>• **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.71 compared to No Action.<br>• No intersite transport of LLW. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations.<br>• **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.70 compared to No Action.<br>• No intersite transport of LLW. |
| | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS.<br>• No intersite transport of LLW. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS.<br>• No intersite transport ofLLW. |
| | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. |

**Intersite Transport of Weapons Complex Materials**

| ORR | Pantex | SRS |
|---|---|---|
| • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS.<br>• The potential risk for transporting heavy water is $1.4 \times 10^{-5}$ cancer fatalities. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **No Tritium Supply Alone.** |
| • No intersite transport of LLW. | • For intersite transportation of low-level waste, credible accidents associated with locating a HWR would result in risks of $2.8 \times 10^{-8}$ fatal cancers per year from radiological releases and $3.70 \times 10^{-4}$ from nonradiological releases.<br>• The potential risk for transporting heavy water is $1.4 \times 10^{-5}$ cancer fatalities. | |
| • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. |
| • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.87 compared to No Action. | • **Collocated Supply and Recycling**—The risk is zero because there is no intersite transportation of tritium when tritium supply and recycling are collocated with the assembly and disassembly function. | • **Tritium Supply and Upgraded Recycling**—The transportation risk of tritium for this alternative the same as No Action. |
| • No intersite transport of LLW. | • For intersite transportation, credible accidents associated with locating an MHTGR at Pantex would result in risks of $8.78 \times 10^{-9}$ fatal cancers per year from radiological releases and $1.16 \times 10^{-4}$ fatalities per year from nonradiological causes. | • No intersite transport of LLW. |
| • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **No Tritium Supply Alone.** |
| • No intersite transport of LLW. | • For intersite transportation of LLW, credible accidents associated with locating a MHTGR would result in risks of $7.15 \times 10^{-9}$ fatal cancers per year from radiological releases and $9.46 \times 10^{-5}$ from nonradiological releases. | |
| • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. |

**Intersite Transport of Weapons Complex Materials**

| Technology | INEL | NTS |
|---|---|---|
| **Advanced Light Water Reactor** | • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.71 compared to No Action. | • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.70 compared to No Action. |
| | • No intersite transport of LLW. | • No intersite transport of LLW. |
| | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. |
| | • No intersite transport of LLW. | • No intersite transport of LLW. |
| | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. |
| **Accelerator Production of Tritium** | • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.71 compared to No Action. | • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.70 compared to No Action. |
| | • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. | • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. |
| | • No intersite transport of LLW. | • No intersite transport of LLW. |
| | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. |
| | • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. | • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. |

**Intersite Transport of Weapons Complex Materials**

| ORR | Pantex | SRS |
|---|---|---|
| • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.87 compared to No Action. | • **Collocated Supply and Recycling**—The risk is zero because there is no intersite transportation of tritium when tritium supply and recycling are collocated with the assembly and disassembly function. | • **Tritium Supply and Upgraded Recycling**—The relative transportation risk of tritium for this alternative is the same as No Action. |
| • No intersite transport of LLW. | • For intersite transportation of low-level waste, credible accidents associated with locating a Large or Small ALWR at Pantex would result in risks of $1.04 \times 10^{-8}$ for the large and $5.85 \times 10^{-9}$ fatal cancers per year, respectively, from radiological releases and $1.38 \times 10^{-4}$ and $7.74 \times 10^{-5}$ fatalities per year from nonradiological causes. | • No intersite transport of low-level waste. |
| • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **No Tritium Supply Alone.** |
| • No intersite transport of LLW. | • For intersite transportation of LLW, credible accidents associated with locating a Large or Small ALWR at Pantex would result in risks of $8.45 \times 10^{-9}$ or $4.22 \times 10^{-9}$ fatal cancers per year from radiological releases and $1.12 \times 10^{-4}$ or $5.59 \times 10^{-5}$ fatalities per year from nonradiological causes. | |
| • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations**—Transportation risk is approximately 50 percent of baseline tritium requirement operations. |
| • **Collocated Supply and Recycling**—The relative transportation risk of tritium for this alternative is 0.87 compared to No Action. | • **Collocated Supply and Recycling**—The risk is zero because there is no intersite transportation of tritium when tritium supply and recycling are collocated with the assembly and disassembly function. | • **Tritium Supply and Upgraded Recycling**—The transportation risk of tritium for this alternative is the same as No Action. |
| • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. | • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. | • No transport of heavy water, thus no risk. |
| • No intersite transport of LLW. | • For intersite transportation, credible accidents associated with locating an APT at Pantex would result in risks of $5.29 \times 10^{-9}$ fatal cancers per year from radiological releases and $6.88 \times 10^{-5}$ for nonradiological releases. | • No intersite transport of LLW. |
| • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **Supply Alone**—The risk for transporting tritium for this alternative is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • **No Tritium Supply Alone.** |
| • The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. | | |

**Intersite Transport of Weapons Complex Materials**

| Technology | INEL | NTS |
|---|---|---|
| **Accelerator Production of Tritium (Continued)** | • No intersite transport of LLW. | • No intersite transport of LLW. |
| | • **Less Than Baseline Operations—** Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations—** Transportation risk is approximately 50 percent of baseline tritium requirement operations. |

**Intersite Transport of Weapons Complex Materials**

| ORR | Pantex | SRS |
|---|---|---|
| • No intersite transport of LLW. | • For intersite transportation of LLW, credible accidents associated with locating an APT would result in risks of $3.25 \times 10^{-9}$ fatal cancers per year from radiological releases and $4.30 \times 10^{-5}$ from nonradiological releases.<br>• The potential risk for transporting heavy water is $6.63 \times 10^{-6}$. | |
| • **Less Than Baseline Operations—** Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations—** Transportation risk is approximately 50 percent of baseline tritium requirement operations. | • **Less Than Baseline Operations—** Transportation risk is approximately 50 percent of baseline tritium requirement operations. |

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**Department of Energy**
Washington, DC 20585

February 28, 1995

Dear Interested Party:

The Draft Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling has been completed. A public comment period will extend through May 15, 1995.

Tritium, a radioactive gas used in all of the Nation's nuclear weapons, has a short half-life and must be replaced periodically in order for the weapon to operate as designed. Currently, the Nation has no tritium production capability.

The Tritium Supply and Recycling PEIS evaluates the alternatives for the siting, construction, and operation of tritium supply and recycling facilities at each of five candidate sites: the Idaho National Engineering Laboratory, the Nevada Test Site, the Oak Ridge Reservation, the Pantex Plant, and the Savannah River Site. Alternatives for new tritium supply and recycling facilities consist of four different tritium supply technologies; Heavy Water Reactor, Modular High Temperature Gas-Cooled Reactor, Advanced Light Water Reactor, and Accelerator Production of Tritium. The PEIS also evaluates the impacts of using a commercial light water reactor, either as a contingency in the event of a national emergency or if purchased by the Department and converted to defense purposes. Additionally, the PEIS includes an analysis of multi-purpose reactors which would produce tritium, dispose of plutonium and produce electricity.

All interested parties are invited to submit comments by regular mail, by calling the Tritium Supply and Recycling toll free number at 1-800-776-2765, or electronically via computer with a modem or through Internet. For information on mailing comments or sending them electronically, please call the toll free number. Public hearings on the Draft PEIS are scheduled to begin April 5 and run through April 20, 1995. Specific information regarding these hearings can also be obtained by calling the above toll free number.

Sincerely,

Stephen M. Sohinki
Director
Office of Reconfiguration

DOE/EIS-0161

# Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling

## Volume II

United States Department of Energy
Office of Reconfiguration

February 1995

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# ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

# Acronyms, Abbreviations, and Conversion Charts

## Acronyms and Abbreviations

| | |
|---|---|
| APT | Accelerator Production of Tritium |
| ALWR | Advanced Light Water Reactor |
| AQCR | Air Quality Control Region |
| CAA | *Clean Air Act* |
| CEQ | Council on Environmental Quality |
| CERCLA | *Comprehensive Environmental Response, Compensation, and Liability Act* |
| CFR | Code of Federal Regulations |
| CWA | *Clean Water Act* |
| D&D | decontamination and decommissioning |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOI | Department of the Interior |
| DOT | Department of Transportation |
| DP | DOE Office of the Assistant Secretary for Defense Programs |
| EA | environmental assessment |
| EIS | environmental impact statement |
| EM | DOE Office of the Assistant Secretary for Environmental Management |
| EPA | Environmental Protection Agency |
| ES&H | environment, safety, and health |
| HAP | hazardous air pollutants |
| HE | high explosive(s) |
| HEPA | high efficiency particulate air |
| HEU | highly enriched uranium |
| HI | Hazard Index |
| HLW | high-level waste |
| HQ | Hazard Quotient |
| HWR | Heavy Water Reactor |
| INEL | Idaho National Engineering Laboratory |
| IP | implementation plan |
| $L_{eq}$ | equivalent sound level |
| LLW | low-level waste |
| MHTGR | Modular High Temperature Gas-Cooled Reactor |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | *National Environmental Policy Act* of 1969 |
| NESHAP | National Emissions Standards for Hazardous Air Pollutants |
| NOI | Notice of Intent |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| NRHP | National Register of Historic Places |
| NTS | Nevada Test Site |
| ORNL | Oak Ridge National Laboratory |

| | |
|---|---|
| ORR | Oak Ridge Reservation |
| OSHA | Occupational Safety and Health Administration |
| PEIS | programmatic environmental impact statement |
| $PM_{10}$ | particulate matter of aerodynamic diameter less than 10 micrometers |
| RCRA | *Resource Conservation and Recovery Act* |
| ROD | Record of Decision |
| ROI | region-of-influence |
| SAR | Safety Analysis Report |
| SARA | *Superfund Amendments and Reauthorization Act* |
| SDWA | *Safe Drinking Water Act* |
| SHPO | State Historic Preservation Officer |
| SRS | Savannah River Site |
| START | Strategic Arms Reduction Treaty |
| TOC | total organic compounds |
| TRU | transuranic |
| TSCA | *Toxic Substances Control Act* |
| TSP | total suspended particulates |
| TSS | tritium supply site |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| VOC | volatile organic compounds |
| VRM | Visual Resource Management |
| WIPP | Waste Isolation Pilot Plant |

## Chemicals and Units of Measure

| | |
|---|---|
| BGY | billion gallons per year |
| Ci | Curie |
| $CC1_4$ | carbon tetrachloride |
| CO | carbon monoxide |
| CFC | chlorofluorocarbons |
| dB | decibel |
| dBA | decibel A-weighted |
| DCE | 1, 2-dichlororethylene |
| F | Fahrenheit |
| $ft^2$ | square feet |
| $ft^3$ | cubic feet |
| $ft^3/s$ | cubic feet per second |
| g | gram |
| gal | gallon |
| GPD | gallons per day |
| gpm | gallons per minute |
| GPY | gallons per year |
| HCFC-22 | chlorodifluoromethane |
| HMX | cyclotetramethylenetetranitramine or 1, 3, 5, 7-tetranitro-1, 3, 5, 7-tetrazocine |
| hr | hour |
| kg | kilogram |
| kV | kilovolt |
| kVA | kilovolt-ampere |
| kW | kilowatt |
| kWh | kilowatt hour |
| lb | pound |
| lb/hr | pounds per hour |
| lb/yr | pounds per year |
| Li | lithium |
| mCi | millicurie (one-thousandth of a Curie) |
| mCi/ml | millicurie per milliliter |
| mg | milligram (one-thousandth of a gram) |
| mg/l | milligram per liter |
| MGD | million gallons per day |
| MGY | million gallons per year |
| mrem | millirem (one-thousandth of a rem) |
| MVA | megavolt-ampere |
| MW | megawatt |
| MWe | megawatt electric |
| MWh | megawatt hour |
| MWt | megawatt thermal |
| nCi | nanocurie (one-billionth of a Curie) |

| | |
|---|---|
| nCi/g | nanocuries per gram |
| $NO_2$ | nitrogen dioxide |
| $NO_X$ | nitrogen oxides |
| $O_3$ | ozone |
| Pb | lead |
| PCB | polychlorinated biphenyl |
| pCi | picocurie (one-trillionth of a Curie) |
| pCi/l | picocuries per liter |
| PETN | pentaerythritoltetranitrate |
| ppb | parts per billion |
| ppm | parts per million |
| Pu | plutonium |
| RDX | cyclotrimethylenetrinitramine |
| rem | roentgen equivalent man |
| $SO_2$ | sulfur dioxide |
| TATB | triaminotrinitrobenzene |
| TCA | 1, 1, 1-trichloroethane |
| TCE | trichloroethylene |
| TNT | trinitrotoluene |
| U | uranium |
| $yd^3$ | cubic yards |
| µCi | microcurie (one-millionth of a Curie) |
| µCi/g | microcuries per gram |
| µg | microgram (one-millionth of a gram) |
| µg/kg | micrograms per kilogram |
| µg/l | micrograms per liter |
| $\mu g/m^3$ | micrograms per cubic meter |
| µm | micron or micrometer (one-millionth of a meter) |

## Metric Conversion Chart

| To Convert Into Metric | | | To Convert Out of Metric | | |
|---|---|---|---|---|---|
| **If You Know** | **Multiply By** | **To Get** | **If You Know** | **Multiply By** | **To Get** |
| **Length** | | | | | |
| inches | 2.54 | centimeters | centimeters | 0.3937 | inches |
| feet | 30.48 | centimeters | centimeters | 0.0328 | feet |
| feet | 0.3048 | meters | meters | 3.281 | feet |
| yards | 0.9144 | meters | meters | 1.0936 | yards |
| miles | 1.60934 | kilometers | kilometers | 0.6214 | miles |
| **Area** | | | | | |
| sq. inches | 6.4516 | sq. centimeters | sq. centimeters | 0.155 | sq. inches |
| sq. feet | 0.092903 | sq. meters | sq. meters | 10.7639 | sq. feet |
| sq. yards | 0.8361 | sq. meters | sq. meters | 1.196 | sq. yards |
| acres | 0.40469 | hectares | hectares | 2.471 | acres |
| sq. miles | 2.58999 | sq. kilometers | sq. kilometers | 0.3861 | sq. miles |
| **Volume** | | | | | |
| fluid ounces | 29.574 | milliliters | milliliters | 0.0338 | fluid ounces |
| gallons | 3.7854 | liters | liters | 0.26417 | gallons |
| cubic feet | 0.028317 | cubic meters | cubic meters | 35.315 | cubic feet |
| cubic yards | 0.76455 | cubic meters | cubic meters | 1.308 | cubic yards |
| **Weight** | | | | | |
| ounces | 28.3495 | grams | grams | 0.03527 | ounces |
| pounds | 0.45385 | kilograms | kilograms | 2.2034 | pounds |
| short tons | 0.90718 | metric tons | metric tons | 1.1023 | short tons |
| **Temperature** | | | | | |
| Fahrenheit | Subtract 32 then multiply by 5/9ths | Celsius | Celsius | Multiply by 9/5ths, then add 32 | Fahrenheit |

## Metric Prefixes

| Prefix | Symbol | Multiplication Factor |
|---|---|---|
| exa- | E | 1 000 000 000 000 000 000 = $10^{18}$ |
| peta- | P | 1 000 000 000 000 000 = $10^{15}$ |
| tera- | T | 1 000 000 000 000 = $10^{12}$ |
| giga- | G | 1 000 000 000 = $10^{9}$ |
| mega- | M | 1 000 000 = $10^{6}$ |
| kilo- | k | 1 000 = $10^{3}$ |
| hecto- | h | 100 = $10^{2}$ |
| deka- | da | 10 = $10^{1}$ |
| deci- | d | 0.1 = $10^{-1}$ |
| centi- | c | 0.01 = $10^{-2}$ |
| milli- | m | 0.001 = $10^{-3}$ |
| micro- | μ | 0.000 001 = $10^{-6}$ |
| nano- | n | 0.000 000 001 = $10^{-9}$ |
| pico- | p | 0.000 000 000 001 = $10^{-12}$ |
| femto- | f | 0.000 000 000 000 001 = $10^{-15}$ |
| atto- | a | 0.000 000 000 000 000 001 = $10^{-18}$ |

# APPENDIX A

# Appendix A

# APPENDIX A: NUCLEAR FACILITIES

The Nuclear Weapons Complex (Complex) is comprised of facilities located at 11 major U.S. Department of Energy (DOE) sites, distributed over 10 states. Summary descriptions of the Complex sites considered for tritium supply and recycling are presented in chapters 1, 3, and 4. This appendix examines in more detail four Complex sites and one other, the Idaho National Engineering Laboratory (INEL), which is being considered as a potential addition to the Complex.

The five DOE sites described in appendix A include INEL, the Nevada Test Site (NTS), the Oak Ridge Reservation (ORR), the Pantex Plant, and the Savannah River Site (SRS). The first section of this appendix provides detailed reference operation assumptions for each site examined in this PEIS. Information provided includes specific site location descriptions, current missions, facility operations, and environmental regulatory compliance activities associated with ongoing DOE Office of the Assistant Secretary for Defense Programs (DP), other DOE, and non-DOE programs.

The next section of this appendix is divided into two parts. First is the detailed description of the tritium supply technologies. This is followed by a detailed description of the tritium recycling facilities which could be either new collocated facilities or, in the case of SRS, upgrade modifications to existing facilities. Each description includes specific information describing missions, assumptions, functional parameters, expected capabilities, process descriptions, special process requirements, utilities, chemicals used, operational resources, transportation, and environmental regulatory setting. The final section discusses tritium supply technology options which are outside the scope of this Programmatic Environmental Impact Statement (PEIS).

## A.1 Reference Operating Assumptions

The reference case for the Tritium Supply and Recycling PEIS is No Action, which was previously described in section 3.2.1. No Action allows a comparison of tritium supply alternatives for the candidate sites, not against the current nuclear weapons facility configuration, but against the configuration as it would be expected to operate in 2010 and beyond.

No Action assumes that all nuclear sites of the current Complex would continue their current missions only with existing facilities that can comply with environment, safety, and health (ES&H) requirements, and at a level that is consistent with current DOE guidance. The basic missions assigned to the sites include the following: research, development, and testing; maintaining nuclear weapons production and testing capability; processing and storage of nuclear materials; operation of an extensive transportation safeguards system to assure the safe, secure movement of weapons and strategic quantities of nuclear materials within the continental United States; non-weapon projects; energy programs; and, cooperation with the Department of Defense (DOD) in responding to nuclear accidents or incidents throughout the world.

Under No Action, the siting and construction of a new tritium supply facility would not occur, there would be no upgrades/modifications of existing facilities, and future support of the nuclear weapons stockpile would be provided within the confines of the existing Complex capabilities. Some mission requirements for maintenance of the weapons stockpile in the future would not be met under No Action. However, No Action includes those mission requirements to represent a reference against which tritium supply and recycling alternatives that would meet the Department's *Atomic Energy Act* responsibilities could be compared.

Sites would continue waste management programs to meet the legal requirements and commitments in formal agreements and would proceed with cleanup activities. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for the year 2010 and beyond.

Detailed reference descriptions of the affected nuclear sites follows. These descriptions include discussion of the site location, missions, facility operations, and environmental regulatory compliance.

### A.1.1 Idaho National Engineering Laboratory

**Site Description.** INEL is located in 4 counties and covers 890 square miles in southeastern Idaho near Idaho Falls. The main site is 34 miles west of Idaho Falls, 38 miles northwest of Blackfoot, and 22 miles east of Arco. There is also an annex in Idaho Falls. The facility covers more than 569,000 acres with approximately 277 miles of roads, both paved and unpaved, and 30 miles of railroad track (figure 4.2.1–1 and table 4.2.2.2–1).

There are 450 buildings and 2,000 support structures at INEL with more than 3 million square feet ($ft^2$) of floor space in varying conditions of utility. INEL has approximately 270,000 $ft^2$ of covered warehouse space and an additional 200,000 $ft^2$ of fenced yard space. The total area of the various machine shops is 32,665 $ft^2$. The majority of experiment sites are no longer in use and are scheduled for decontamination and decommissioning (D&D) and restoration. There are three reactors operating continuously and eight sites that formerly housed reactors, now scheduled for D&D.

Warehouses are located in all onsite areas and, on average, are filled to more than 85 percent of capacity. Also, there are 11 machine shops on the site to support all activities. Besides the main site, there is also an INEL annex in Idaho Falls which has office buildings, a computer center, and a research and development laboratory where site related technical, analytical, and administrative activities are conducted.

Four separate management and operations contractors operate the Idaho Chemical Processing Plant, the Naval Reactor Facility, Argonne National Laboratory-West, and the remainder of the site for DOE. Transportation to and from INEL is provided to all persons employed onsite. There are no long-term housing facilities at INEL. INEL procures more than $25 million worth of material, supplies, and construction services in the region per year.

**Missions.** The missions of INEL are:

- Provide waste management functions.
- Perform waste processing, technology research and development.
- Perform research on reactor safety operations, materials testing and environmental monitoring.
- Perform breeder reactor irradiation tests.
- Perform irradiation service, develop nuclear instruments, and perform geological and defense research.
- Maintain a standby facility for conducting ship propulsion reactor research and training.

**Facility Operations.** Activities at INEL have been divided among nine distinct and geographically separate functional areas (table 3.3.2–1).

- Fuel reprocessing activities at the Idaho Chemical Processing Plant have been terminated and operations are focused on spent fuel storage and high-level waste processing.
- The Radioactive Waste Management Complex is a storage and disposal facility intended primarily for radioactive materials from defense and nuclear energy research programs. The Complex consists of three main areas: an 88-acre subsurface disposal area, a 56-acre transuranic storage area, and an administrative area.
- The Power Burst Facility supports research and development for waste reduction programs. A reactor used for thermal fuels behavior studies is now in a standby mode. Major waste reduction facilities include the Waste Engineering Development Facility, the Waste Experimental Reduction Facility, and the Mixed Waste Storage Facility.
- The Test Area North complex is the northernmost facility within INEL and consists of several experimental reactor and support facilities conducting research and development activities on reactor performance. These include the Technical Support Facility, the Contain-

ment Test Facility, the Water Reactor Research Test Facility, and the Inertial Engine Test Facility. The Inertial Engine Test Facility has been abandoned with no future programs planned. The remaining facilities support ongoing programs that are expected to continue for the foreseeable future.

- The Auxiliary Reactor Area is the site where materials testing and environmental monitoring activities are conducted. The facilities in this area are scheduled for D&D.

- The Argonne National Laboratory-West is dedicated to breeder reactor development.

- The Test Reactor Area supports the Advanced Test Reactor which is used for irradiation testing of fuel, core materials, and instrumentation for naval reactors. Wastes from this facility are handled by the Radioactive Waste Management Complex.

- The Naval Reactors Facility is operated for DOE and U.S. Navy by Westinghouse Electric Corporation under jurisdiction of DOE's Pittsburgh Naval Reactors Office. Activities include the testing of advanced design equipment and new systems for current naval nuclear power propulsion plants and obtaining data for future design.

- The Central Facilities Area provides effective site-wide support services including transportation, shop services, health services, radiation monitoring, and administrative offices.

*Defense Program Activities.* There are no defense program activities currently being performed at INEL.

*Other Department of Energy Activities.* The Test Area North is used for light water reactor safety tests and specific manufacturing. The Naval Reactor Facility contains four reactors (scheduled for shutdown by June 1995) where new designs are tested: the Submarine Prototype (S1W), the Large Ship Reactor (A1W), the Natural Circulation Submarine Prototype (S5G), and the Expended Core Facility. At the Test Reactor Area, the Advanced Test Reactor is currently operating to test reactor fuel, targets, core materials, and electronics. The Engineering Test Reactor and the Materials Test Reactor are in standby and the buildings are used for offices and test laboratories. The Auxiliary Reactor Area is being utilized for materials testing, but is scheduled for D&D in the near future. The Power Burst Facility reactor is on standby, but the area is used for low-level waste (LLW) engineering and development and for mixed waste storage. Argonne National Laboratory-West operates an Experimental Breeder Reactor for research and development. The Radioactive Waste Management Complex is used for examination and certification of INEL wastes. It also provides for storage of retrievable transuranic (TRU) wastes and disposal of low-level radioactive (beta-gamma) waste. The Central Facilities Area provides support services for the entire site. There are a variety of support and service organizations onsite. These include the facilities to handle security, fire protection, facilities service and maintenance, food preparation, mail, transportation, medical, communication, warehousing, and machine shops.

*Non-Department of Energy Activities.* There are non-DOE activities at INEL which include research being conducted by the National Oceanic and Atmospheric Administration, the U.S. Geological Survey, and various institutions of higher learning. These activities support the designation of INEL as a National Environmental Research Park.

**Environmental Regulatory Setting.** The Environmental Oversight and Monitoring Agreement between DOE and the State of Idaho, signed May 21, 1990, was developed to assure the citizens of Idaho that their health and safety and the environment are being protected. This voluntary agreement addresses understandings and commitments between the parties regarding DOE's provision to the State of Idaho of technical and financial support for state activities to assess compliance with applicable laws and regulations at INEL. These activities consist of environmental oversight, monitoring, and evaluations of emergency response plans. The independent monitoring includes onsite discharges, groundwater

and air quality, and offsite radioactivity, as well as evaluation of waste minimization planning and source reduction methods. This agreement has been extended until negotiations for a new agreement are completed and approved. Negotiations begin in the fall of 1994 and are expected to conclude in 1995.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at INEL. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones.

On December 21, 1989, EPA placed INEL on the National Priorities List (NPL) as a "Superfund Site" pursuant to the provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA). This determination was based on the contamination present due to past practices.

*Air.* The INEL air emission inventory, completed in March 1991, catalogs all vents and stacks at INEL. The air toxics inventory for radioactive and other hazardous air pollutants is being compiled and, when added to the air emissions inventory, will serve as the basis for the operating permits required under Title V of the *Clean Air Act* (CAA) *Amendments* of 1990. INEL is in full compliance with *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H), with an effective dose equivalent to the public for 1991 at 0.004 millirem (mrem) per year (IN DOE 1992d:34).

The Idaho Operations Office signed a Consent Order on February 11, 1992, with the State of Idaho whereby INEL agreed to pay a monetary penalty and to apply for the appropriate air quality permit for the construction and operation of potential air pollution sources. A Notice of Violation issued in June 1991 alleged these facilities had been constructed without the required permits.

In addition to the Notice of Violation, there has been litigation over the need for an air quality permit for the storage of the Fort St. Vrain spent nuclear fuel at the Idaho Chemical Processing Plant-Building 603 Facility. The June 28, 1993, decision of the U.S. District Court for the District of Idaho barred any further transportation, receipt, processing, or storage of spent nuclear fuel at INEL until all requirements of *National Environmental Policy Act* of 1969, (NEPA) are met. The decision came in a suit filed in 1991 in the case of *Public Service Company of Colorado* v. *Cecil Andrus* (Governor of Idaho), Docket No. 91-0035-S-HLR, and *United States* v. *Cecil Andrus*, Docket No. 91-00540S-HLR. DOE and Public Service Company of Colorado sued the Governor of Idaho who had prevented the Public Service Company of Colorado from shipping spent nuclear fuel from the Fort St. Vrain reactor to INEL. The court ordered DOE to prepare a comprehensive environmental impact statement (EIS) on all major Federal actions involving the transportation, receipt, processing, and storage of spent nuclear fuel at INEL. This order also halted shipments of spent nuclear fuel to INEL until the EIS is completed. As a result of this order, DOE, the U.S. Navy, and the State of Idaho reached the Idaho Agreement on August 9, 1993. The Idaho Agreement encompasses the transportation, receipt, processing, and storage of spent nuclear fuel at INEL. This agreement is a negotiated settlement among the parties to satisfy the U.S. District Court's June 28 decision. Under the terms of this agreement, DOE agrees to complete not later than April 30, 1995, an EIS on transportation, receipt, processing, and storage of spent nuclear fuel at INEL. DOE also agrees to halt further shipments of spent nuclear fuel to INEL except for 19 naval spent nuclear fuel shipments specified in the agreement until after a decision supported by the EIS is made.

*Water.* The Snake River Plain aquifer, a sole source aquifer which lies beneath INEL, serves as the source for drinking water and crop irrigation in the Snake River Basin. Natural radioactivity is found in the Snake River Plain aquifer in areas upgradient, parallel to, and distant from INEL. Onsite and offsite water samples are collected routinely to monitor the movement of waste substances, both radioactive and nonradioactive, through the aquifer onsite. Onsite drinking water samples are collected monthly from production drinking water wells in use at active site facilities. Approximately 25 percent of all drinking water samples collected in 1991, contained detectable concentrations of gross alpha activity.

The Idaho Operations Office submitted applications to the State of Idaho for two National Pollutant Discharge Elimination System (NPDES) permits in January 1992. These permit requests are for discharges of noncontact cooling water and for discharges of wastewater to the Big Lost River from the Idaho Chemical Processing Plant. No other INEL facility discharges liquid effluents to surface waters other than stormwater, and no streams or rivers flow from within INEL to locations outside the boundaries. In addition to the two NPDES permits, INEL has filed nine deep injection well permit applications with the State of Idaho. The injection wells are used to dispose of stormwater runoff. DOE continues to update the inventory of shallow injection wells.

On October 7, 1992, the Idaho Operations Office signed a Consent Order with the State of Idaho to settle the Notice of Violation issued on June 7, 1991, for alleged violation of Idaho water quality regulations. The Notice of Violation alleges that the Idaho Operations Office is subject to a state permit program for systems treating wastewater by application to the land via percolation ponds and unlined sewage systems at the Idaho Chemical Processing Plant. DOE will obtain stormwater discharge permits under NPDES. Also, draft wastewater land application permits have been issued and are currently being negotiated. INEL is currently covered under two general permits: stormwater discharges associated with industrial activity and construction activity.

*Land. The Idaho Hazardous Waste Management Act* and EPA delegation of authority to the state provides the Idaho Department of Health and Welfare authority to enforce hazardous waste management regulations and to provide oversight of *Resource Conservation and Recovery Act* (RCRA) related environmental restoration activities. INEL has an approved RCRA Part A treatment, storage, and disposal permit and has submitted for approval the RCRA Part B permit application.

In 1989, the Governor of the State of Idaho placed a moratorium on the receipt of TRU wastes from out-of-state. INEL is honoring the governor's moratorium even though solid radioactive wastes from Rocky Flats Environmental Technology Site (formerly known as the Rocky Flats Plant) have been received and buried at INEL since 1954. Offsite generators, including the Rocky Flats Environmental Technology Site and the Mound Plant, which had been approved to make routine waste shipments to the Radioactive Waste Management Complex at INEL, are adversely affected. INEL has also agreed to terminate TRU waste disposal activities on INEL. TRU waste not buried prior to this agreement is being stored at the Radioactive Waste Management Complex in compliance with applicable regulatory requirements, awaiting permanent disposal at a Federal repository.

Three areas of confirmed releases of contamination to the environment at INEL have been identified:

- The Radioactive Waste Management Complex, where small amounts of volatile organic compounds have been measured in the groundwater aquifer and trace concentrations of TRU radionuclides were detected at a 110-foot depth above the aquifer. Both contaminants are suspected to be traceable to buried TRU waste. Additional contaminants that potentially may be released include petroleum products, acids, bases, volatile organic compounds, heavy metals, radionuclides, polychlorinated biphenyls (PCBs), and asbestos.

- The Test Reactor Area, where chromium compounds have been detected beneath a wastewater pond in groundwater that is perched above the Snake River Plain aquifer. Remedial action is underway.

- The Test Area North groundwater, where volatile organic compounds were measured in wells that supply drinking water. Remedial action is underway.

DOE entered into a Federal Facility Agreement and Consent Order with EPA and the State of Idaho. The agreement, signed December 9, 1991, meets the requirement of Section 120(e) of CERCLA (42 U.S.C. § 9601 *et seq.*) for an interagency agreement with EPA for Federal agencies that have facilities included on the NPL. The Federal Facility Agreement and Consent Order is implemented by an Action Plan outlining the remedial action process, which will encompass investigation of hazardous substances and cleanup activities at INEL.

The purposes of the Federal Facility Agreement and Consent Order Action Plan are to:

- Establish a procedural framework and schedule for developing and monitoring appropriate response actions at INEL in accordance with CERCLA, RCRA, and the Idaho *Hazardous Waste Management Act.*

- Facilitate cooperation, exchange of information, and participation of the parties in such actions.

- Minimize duplication of analyses and documentation.

- Expedite the clean-up process to the maximum extent possible consistent with protection of human health and the environment.

- Supersede the existing RCRA 3008(h) Consent Order and Compliance Agreement executed on July 10, 1987.

In February 1990, INEL received a Notice of Noncompliance issued by EPA on January 29, 1990, for 28 alleged violations of RCRA regulations based on a June 5 to 9, 1989, inspection. The majority of violations have been resolved and long-term technical solutions for the Radioactive Waste Management Complex and Idaho Chemical Processing Plant have been agreed upon. On April 3, 1992, the Idaho Operations Office, the State of Idaho, and EPA Region 10 signed a Consent Order to settle the unresolved issues from the 1990 Notice of Noncompliance. The sodium in Building 703 (1,400 55-gallon drums) at the Argonne National Laboratory-West site has been declared a waste. DOE has agreed to manage the sodium in Building 703, "...in compliance with all applicable interim status provisions of the *Hazardous Waste Management Act* and the Rules, Regulations and Standards for Hazardous Waste..." (IN DOE 1993a:124). The Consent Order sets up a schedule for corrective actions to be taken in the management of radioactive sodium bearing liquid wastes currently stored at the Idaho Chemical Processing Plant in the tanks with concrete vault secondary containment. Because the concrete vaults would react with the acidic solutions stored in the tanks, they do not meet RCRA requirements for secondary containment of hazardous wastes. The corrective actions at the Radioactive Waste Management Complex, Argonne National Laboratory-West, and the Idaho Chemical Processing Plant could take more than 25 years.

On October 7, 1992, the Idaho Operations Office signed another Consent Order with the State of Idaho to resolve the Hazardous Waste Notice of Violation issued by the state on June 5, 1991, for 23 alleged hazardous waste violations identified during the September 10 to 14, 1990, inspection. This Consent Order provides the schedule for corrective actions such as establishing satellite accumulation areas, closure of the Idaho Chemical Processing Plant percolation ponds, and discontinuing the discharge of non-RCRA wastewater into the percolation ponds prior to formal "clean" closure. Completion of these actions will resolve this Notice of Violation.

INEL generates mixed wastes that are radioactive and contain RCRA hazardous wastes banned from land disposal. The primary INEL compliance concerns for mixed wastes are the radioactively-contaminated wastes containing solvents and California list wastes as defined in 40 CFR 268.5. These mixed wastes are subject to the RCRA land disposal restrictions which ban the land disposal of certain listed hazardous wastes unless they meet specific treatment standards. Due to the nationwide shortage of treatment and disposal facilities for these types of waste, INEL is storing these mixed wastes until better treatment and disposal options are developed. Such storage violates the Land Disposal Restrictions provisions of RCRA which permits storage only for accumulation of sufficient quantities to facilitate proper treatment, recycle, or disposal. Therefore, the Idaho Operations Office has proposed to enter into a compliance agreement with DOE and the State of Idaho concerning the storage and continued generation of land disposal restriction waste until a treatment method is developed and WIPP or another suitable repository is open for disposal of mixed TRU waste. The land disposal restrictions also prohibit the storage of new restricted waste, including storage of new calcine, generated after May 1992, unless it is being accumulated to facilitate the proper treatment, disposal, or recovery, or there is an approved case-by-case extension. Because there are more than one million pounds of radiologically contaminated lead at INEL, serious efforts are being made to develop a

lead treatment process that can satisfy the land disposal restriction.

Schedules to develop such technologies are proposed in the draft Site Treatment Plan. When finalized, the Site Treatment Plan will satisfy DOE's obligation under the *Federal Facility Compliance Act* of 1992 to develop and submit a mixed waste treatment plan for INEL.

INEL is not presently in full compliance with the *Toxic Substances Control Act* (TSCA) due to the storage of some PCB-contaminated equipment and materials. The equipment and materials are also contaminated by various radioactive elements and treatment and disposal technology does not currently exist for these materials. DOE has an aggressive program to develop this technology but until it does, these materials must be safely stored in violation of the TSCA ban on the storage of such materials. DOE is presently negotiating a compliance agreement with the State of Idaho for the continued storage of radioactive PCB-contaminated wastes at INEL until a method for their treatment or disposal can be developed and permitted.

### A.1.2 Nevada Test Site

**Site Description.** NTS is located in Nye County, NV, and encompasses approximately 864,000 acres (1,350 square miles). It varies in width from 28 to 35 miles (east to west) and in length from 40 to 55 miles (north to south). To the north, east, and west, the rugged, mountainous, undeveloped, Federal-owned land masses of the Nellis Air Force Range provide a buffer zone, varying from 15 to 65 miles wide, between the test areas and public lands. The Bureau of Land Management manages the land which borders the southern and southwestern boundaries. United States Highway 95 and the town of Amargosa Valley are also to the south. The southeast corner of NTS is about 65 miles northwest of Las Vegas.

NTS is unique in that it is a large open area for which access is tightly controlled, with adequate infrastructure, to handle and run tests with hazardous or radioactive materials. Approximately 25 percent of NTS is currently undeveloped or provides buffer zones for on-going programs and projects. Facility expansions are possible within all areas and encroachment from land development is not a concern.

NTS is divided into numbered test areas to simplify the distribution, use, and control of resources (figure 4.3.1–1). The main entrance and the Desert Rock airstrip are at the southeast corner of the site (Area 22). Mercury base camp is adjacent in Area 23 and provides administrative operations and general support. Offices for DOE, DOD, Defense Nuclear Agency, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Sandia National Laboratories, New Mexico, and all of the supporting contractors of these organizations are located in this area. Dormitory, cafeteria, recreation, and transportation facilities are located here.

North of Mercury is Frenchman Flat (Area 5), an area historic for its atmospheric nuclear tests. Just north of Frenchman Flat is Area 6. The Control Point One facility which provides control over and execution of nuclear detonations at NTS is located here as is a new work-camp for construction and craft support. A shallow, usually dry, lake bed, Yucca Lake, is also in this area. Further north is the broad valley of Yucca Flat, site of much of the more recent nuclear testing (Areas 1, 2, 3, 4, 7, 9, and 10). At the northern edge of this flat at the base of Rainier Mesa, is the center of DOD/Defense Nuclear Agency activities (Area 12). The Area 12 Camp has logistic, service, and administration facilities, which, in busier times, supported the northern part of NTS but which has now been closed and consolidated with the Mercury and Area 6 camps. The Area 12 Camp provided ready access to the Defense Nuclear Agency tunnels mined into the face of Rainier Mesa. In the northwest section of NTS is Pahute Mesa. Its geology, combined with the greater distance from Las Vegas, allows its use for testing nuclear devices with larger yields (Areas 19 and 20).

Due to its large size, the perimeter of NTS is not fenced. However, roving security guards patrol the test site. Security and hazardous areas are fenced and some are protected with armed guards and electronic security measures. Capital assets at NTS include about 1,200 buildings with 8,000 units of installed equipment, approximately 300 miles of primary and secondary surfaced roads, and 400 miles of unsurfaced roads.

The NTS water system consists of 15 wells, pumps, booster pumps, and many sumps, reservoirs, chlorinator water softeners, and 100 miles of supply and

distribution lines. This water system has an average weekly production of 8.5 million gallons. Total well capacity is 5,752 gallons per minute (gpm). Twelve wells supply water for domestic use on NTS. Mercury basecamp is supplied by 3 wells: 2 in Area 5 and 1 near Desert Rock Airstrip.

Electrical power to NTS is supplied by Nevada Power Company and Valley Electric Association transmission lines. Both transmission lines are rated at 138 kilovolt (kV). The Nevada Power Company line is approximately 60 miles long and ties into the NTS transmission system near Mercury. The Valley Electric Association line is more than 100 miles long. It runs from the Amargosa Valley substation and ties into the NTS transmission system at Jackass Flats substation. This system (the Nevada Power Company/Valley Electric Association transmission lines) is capable of providing 45 megawatt electric (MWe) based on a single contingency failure. NTS has over 700 miles of overhead and underground transmission and distribution power lines. NTS also uses a small amount of fuel oil. Table 4.3.2.2–1 shows the annual usage of resources.

**Missions.** The missions of NTS include:

- Provide the capability to conduct underground nuclear weapons tests.
- Provide technology, facilities and expertise for non-DOE customers.
- Support site characterization of Yucca Mountain.
- Conduct environmental assessment and remediation.
- Provide the DOE response for radiological or malevolent nuclear emergencies.
- Dispose of low-level radioactive waste for DOE.
- Conduct offsite technical monitoring for nuclear treaty compliance.

**Facility Operations.** In December 1950, President Truman established the Nevada Proving Grounds (forerunner to NTS) as the Nation's on-continent nuclear weapons testing area. The first nuclear test at NTS occurred on January 27, 1951. At that time, the nuclear weapons program was administered by the Atomic Energy Commission Albuquerque Operations Office. Atomic Energy Commission employees were sent to the Nevada Proving Grounds for the duration of a test series and then returned to Albuquerque. As tests became more frequent during the 1960's, Atomic Energy Commission created the Las Vegas-based Nevada Operations Office, which officially opened on March 6, 1962, and has administered NTS operations since then. Approximately 40 percent of the total Nevada Operations Office budget for fiscal year 1992 was for defense programs activities.

NTS is operated by four major management and operations contractors. Contractor employment levels at the test site are dependent upon programmatic requirements and have varied greatly during the history of the site. During 1988, the peak year, roughly 11,000 contractor employees were assigned to Nevada Operations Office administered activities at NTS and miscellaneous other locations, including metropolitan Las Vegas and North Las Vegas, Nevada. From that peak employment level, and particularly in view of the test moratorium that was first implemented in the fall of 1992, contractor employment levels have decreased to approximately 8,700 as of June 1, 1994; and are predicted to decline further to approximately 8,000 as of September 30, 1994.

The majority of the facilities at NTS were constructed 25 to 30 years ago as temporary structures; less than ten percent have been constructed in the past 15 years. Many of the facilities are also currently inadequate in one or more of the structural, mechanical, or electrical categories. Although Mercury basecamp has close to 100 percent occupancy and some forward areas are at 80 percent occupancy levels, fiscal pressures are forcing the closure of the forward area facilities and consolidation at the Mercury basecamp. Consequently, most of the Mercury facilities are occupied with little reserve capacity.

Desert Rock Air Strip is located southwest of Mercury. The airstrip has in busier times provided scheduled air service by DOE aircraft between NTS and Lawrence Livermore National Laboratory, Los

Alamos National Laboratory, and Sandia National Laboratories, New Mexico, for access by researchers and testing personnel. Currently it is used only for high priority shipments.

Only one major new facility, the Device Assembly Facility, is currently under construction. However, modification of existing facilities on an as needed basis, is an ongoing activity. Drilled holes for groundwater monitoring are always in the process of being selected, designed, and developed. A waste management facility is being considered for handling TRU waste from DOE facilities; this is the only major non-defense program facility anticipated for NTS.

*Defense Program Activities.* Historically, most of the work carried out onsite has been related to defense program activities. Since it was established in December 1950, NTS has been the primary testing location for the Nation's nuclear explosives program. As of September 30, 1992, the United States had conducted 1,054 nuclear tests, 928 which were on the NTS and 828 of which were underground. A breakdown of the categories of the 928 nuclear tests conducted within the boundaries of the NTS from 1951, through 1992, is as follows:

- 100 atmospheric tests, 16 of which were safety tests that by design produced little or no nuclear yields.
- 10 cratering tests (i.e., shallow burial of a nuclear device).
- 9 tests in unstemmed holes to minimize, but not eliminate, the release of radioactivity to the atmosphere.
- 742 underground tests in drilled or mined shafts.
- 67 tunnel tests.

In typical defense program weapons development tests during the past several decades, a nuclear device was emplaced in a vertical drilled hole (86 to 190 inches in diameter) at depths of from 1,200 feet to 2,500 feet in the Yucca Flat basin or at Pahute Mesa. The nuclear device was assembled into the desired testing configuration and mated with a diagnostic equipment canister at NTS. Operational tests were performed repeatedly, both before and after the nuclear device was placed "down-hole," to ensure proper functioning of the telemetry. After the test package, up to 200 feet in length, was lowered to its proper depth, the vertical emplacement hole was backfilled with different materials in order to contain the resulting radioactive debris when the nuclear device was exploded.

A DOE Test Controller at the Area 6 Control Point made the final decision to "Go" or "Not to Go" for each test based upon the recommendations of his safety advisory panel. After detonation, sample recovery holes were bored into the test cavity to obtain samples of the nuclear debris for subsequent radiochemical analysis by the weapons design laboratory that furnished the nuclear device.

As has previously been noted, since the *U.S. Nuclear Testing Moratorium Act* went into effect in early October 1992, no nuclear tests have been conducted by the United States. On the day immediately following China's October 4, 1993, nuclear test, President Clinton issued a directive to DOE to continue to maintain indefinitely a state of readiness for possible resumption of U.S. testing.

The Device Assembly Facility is the only new major facility for defense program activities at NTS. This 100,000 $ft^2$ facility was authorized in 1984, and is under construction now. Physically, it is located just south of Control Point One. It will combine and centralize all the functions and facilities of the existing device assembly area. Once the Device Assembly Facility is operational, Lawrence Livermore National Laboratory and Los Alamos National Laboratory will be able to conduct multiple operations with high explosive(s) (HE) and nuclear devices simultaneously. All aspects of the operations will be handled in this one facility due to its multiple processing areas which include; assembly cells, assembly bays, high bays, radiographic facilities, special nuclear materials laboratories, HE staging, special nuclear materials staging, shipping and receiving areas, and associated administrative and support areas. In addition, the facility will provide for increased overall security and permit easier entrance/exit for the workers during hazardous operations. There will be no manufacturing or machining of special nuclear materials at this facility.

The Nevada Operations Office has been delegated the lead Federal role in maintaining the capability to respond to certain kinds of national emergencies. It will provide the leadership when a Federal Radiological Monitoring and Assessment Center is established. Additionally, a team of highly trained DOE and contractor radiological specialists known as the Nuclear Emergency Search Team trains, tests equipment for search and detection, and stores equipment for rapid deployment under the auspices of the Nevada Operations Office. It can be mobilized in case of accidents involving radioactive materials or a terrorist threat involving nuclear weapons.

*Other Department of Energy Activities.* Although the principal activity at NTS is the underground testing of nuclear devices, DOE is also involved in a number of other activities. These activities include liquified gaseous fuels spill testing, radioactive and mixed waste disposal, and the Yucca Mountain characterization programs. NTS has also been designated a DOE National Environmental Research Park.

The Liquified Gaseous Fuels Spill Test Facility in Area 5 was completed in 1986. It was operated on a fee basis for commercial users as a basic research tool for studying the dynamics of accidental releases of hazardous materials and to evaluate the effectiveness of various foams and fire retardants in accidents involving chemicals and hazardous materials. Test facility personnel discharge a measured volume of hazardous test fluid at a controlled rate onto a surface specially prepared to meet the test requirements and record close-in and downwind meteorological data and gaseous concentration levels.

NTS also operates radioactive waste disposal facilities. The Radioactive Waste Management Site, located in Area 5, accepts LLW materials which were generated in the Nation's defense programs activities. This 92-acre facility consists of trenches and pits for burial of short-lived LLW, and aboveground storage of TRU waste awaiting transfer to the Waste Isolation Pilot Plant (WIPP). Also located at the Area 5 Radioactive Waste Management Site is the Greater Confinement Disposal Facility which consists of a 10 foot diameter lined shaft 120 feet deep. This facility is used for disposal of waste not suited for shallow land burial because of potential for migration into biopathways. Nonradioactive hazardous wastes are also accumulated at the Area 5 Radioactive Waste Management Site awaiting shipment to offsite disposal facilities. In Area 3, the Bulk Waste Management Site uses surface subsidence craters (that were formed by underground nuclear tests) for the emplacement and burial of LLW in bulk form (such as debris collected from atmospheric nuclear test locations).

The Yucca Mountain Site is located at the edge of NTS. It is being considered by DOE for the disposal of spent power-reactor fuel and vitrified high-level waste (HLW), the latter resulting principally from defense program activities. The Yucca Mountain Site Characterization Project staff reports directly to DOE's Office of Civilian Radioactive Waste Management. However, because it has elements based on NTS, the Nevada Operations Office provides some administrative and operational support services to the project. Current designs for the Yucca Mountain Project reflect an electrical demand of 10 MWe; this design has been downsized from earlier estimates of 30 MWe.

Recently, NTS has been designated as a DOE National Environmental Research Park with a purpose of consolidating previous ecological reports, filling in a significant gap in the existing DOE research park network, and providing a unique opportunity for research in the arid desert environment. This not only enables NTS scientists to link into the existing ParkNet computerized data system, but also makes the extensive accumulation of environmental research collected over the history of NTS available to students and scientists throughout the world. NTS's location in the transition zone between the Southern and Northern Basin and Range Ecological Regions, and its inclusion of vast undisturbed areas of mountain ridges, closed basins and diverse ecological communities makes it particularly valuable.

From 1959 through 1973, NTS supported a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests in Area 25 at the Nuclear Research and Development Area. Another series of tests with a nuclear ramjet engine was conducted in Area 26.

*Non-Department of Energy Activities.* The most significant NTS activity involving non-DOE organizations has been the Defense Nuclear Agency's nuclear testing facility. Congressional legislation (the

*Hatfield Amendment*), however, limited nuclear testing to those tests that support the safety and reliability of the U.S. nuclear stockpile. This may preclude further Defense Nuclear Agency nuclear tests which are done to support research into nuclear weapons effects.

Defense Nuclear Agency nuclear tests occurred in horizontal tunnels mined beneath Rainier Mesa. The nuclear devices for these tests were designed, built, funded, controlled, and executed by DP. Defense Nuclear Agency's nuclear testing provided the data base and design information for both nuclear effects and survivability. Nuclear weapons effects were studied for all U.S. tactical and strategic weapons systems that were required to operate in a nuclear warfare environment. These tests played a major role in maintaining high confidence in the nuclear stockpile and nuclear capable weapon systems. The weapons effects tests were conducted to study a number of nuclear effects including X-ray, gamma-ray, neutron, stress (thermal, electrical, and mechanical), electromagnetic pulse, airblast, ground and water shock propagation, and temperature. These tests assessed both weapons effects and the survivability of military systems in a nuclear environment.

Area 85 has been used for a variety of purposes, including U.S. Army ballistic research using depleted uranium and transporter testing for the proposed mobile MX missile. Various military exercises and training activities are also conducted in and around Area 25.

The Desert Research Institute, EPA, the University of Utah, and the Nevada Operations Office operate the Community Radiation Monitoring Program. This program provides the community surrounding NTS with an increased understanding of it's activities and the natural radiation environment.

Other activities have been, and will likely continue to be, carried out for other Federal departments and agencies. Representatives from the EPA, U.S. Geological Survey (USGS), and National Oceanic and Atmospheric Administration are onsite to assist and monitor conditions.

**Environmental Regulatory Setting.** Underground and aboveground testing at NTS has resulted in contamination of surface and subsurface soils and water, and the release of some radioactive isotopes and byproducts, such as metals, into the environment. A Memorandum of Understanding between DOE and the State of Nevada covers radiological releases on NTS and the required notifications. DOE has signed a Programmatic Agreement with the State of Nevada to cover archaeological and historical preservation activities. All future activities at NTS must comply with both the Memorandum of Understanding on radiological releases and the Programmatic Agreement.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at NTS. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. This section discusses the more important agreements and other regulatory issues that must be considered before making a decision that would affect NTS.

An Agreement in Principle with the State of Nevada was signed in October 1990, and provides DOE funding to Nevada for oversight of ES&H activities, including the environmental restoration activities at NTS. The Agreement in Principle also provides for understanding between, and commitment of, the parties regarding DOE's provision to the state for technical and financial support in return for environmental oversight and monitoring. NTS environmental permits include 43 different State of Nevada air quality operating permits involving emissions from construction, operation of facilities, boilers, storage tanks, and open burning. Five permits for onsite drinking water systems, eight permits for hauling septage, and one consolidated permit for four sewage discharges to onsite lagoons or septic tank fields also have been issued by the State of Nevada. The RCRA Part B permit application for hazardous waste was approved by the state in 1990 as number NV3890090001.

*Air.* Air pollution sources at NTS include aggregate production, stemming activities, surface disturbances, fugitive dust from unpaved roads, fuel burning equipment, open burning, and fuel storage

facilities. The air pollutant of major concern at NTS is particulate matter which includes primarily fine sands emitted during stemming and tunneling operations, and carbon particles emitted during fuel combustion. NTS air quality operating permits contain clauses limiting the emission of particulates. Radionuclide emissions are not a problem as no significant emissions of radioactive material from venting, ventilation, or seeps have reached the uncontrolled areas surrounding NTS since 1980.

Many of these air quality operating permits require annual reports on operating hours, production summaries, occurrences of open burning, and other similar information. For example, the Nevada Air Quality Officer must be notified of each burn no later than five days following the burn. During 1990, three open burns of explosives-contaminated debris in Area 27 were reported for this permit. Also, the Nevada Air Quality Officer must be notified by telephone at least two working days in advance of each training exercise for Class A flammables, and a written summary of each exercise must be submitted within 15 days following the exercise. During 1990, seven burns were conducted for radiological emergency response training and ten training burns were conducted by onsite fire protection services.

*Water.* Effluents at NTS are primarily the result of equipment cleaning and sanitary wastes. Discharges also result from groundwater seeping into the tunnels in Rainier Mesa. Tunnels have been sealed with the exception of P-Tunnel which drains to a holding tank. There are no NPDES permits for Nevada Operations Office facilities because there are no wastewater discharges to onsite or offsite surface waters. Water monitoring at NTS was limited to sampling wastewater effluent to lagoons and ponds under a series of State of Nevada permits.

*Land.* NTS manages two radioactive waste management sites and one hazardous waste accumulation site. As a result of its vast area, prior aboveground testing activities, and remote location, NTS serves as a disposal site for LLW generated by onsite and offsite DOE nuclear weapons program activities and facilities. NTS also serves as an interim storage site for TRU and mixed TRU wastes from its own activities and from Lawrence Livermore National Laboratory activities, prior to eventual shipment to WIPP for final disposal. Extensive environmental surveillance is conducted on NTS to monitor the radioactive waste management program sites. NTS previously served as a disposal site for DOE-nuclear-weapons-program-generated mixed wastes received under an interim status provision granted by the State of Nevada. In May 1990, mixed waste disposal operations were discontinued due to EPA issuance of the RCRA land disposal restrictions for the Third Thirds wastes. Active mixed waste disposal operations at the NTS will not commence until issuance of a State of Nevada RCRA Part B permit.

The State of Nevada has been delegated authorization to enforce RCRA by EPA. The Nevada Division of Environmental Protection provides RCRA overview of NTS. The RCRA Part A permit application for NTS was updated in 1990, to include additional onsite disposal units which will be subject to RCRA closures in the future. The RCRA Part B permit application, approved in 1990, for disposal of hazardous waste and storage of mixed waste, is being updated to include all active and proposed expansion of mixed waste storage and disposal units on NTS.

The Hazardous Waste Accumulation Site consists of an impervious concrete pad with 6-inch curbs to contain spillage and runoff and a roof to protect the wastes from rain. This site is used to collect nonradioactive hazardous wastes from satellite accumulation areas prior to shipping offsite to a RCRA-permitted commercial hazardous waste disposal facility. Hazardous waste is removed from NTS in less than 90 days from receipt at the Hazardous Waste Accumulation Site. Final permitting of this site should resolve issues concerning satellite accumulation points for RCRA-generated wastes.

On August 10, 1992, the state notified the Nevada Operations Office of its opinion that the uranium oxide material called Cotter Concentrate stored at NTS is probably a waste that has not yet been declared a waste. The state has requested chemical and physical data regarding the material and, if known to contain RCRA constituents or is uncharacterized, justification should be provided for continuing to classify the material as strategic material, rather than as a waste. On January 8, 1993, DOE declared that this material has no further programmatic use and that it be transferred to waste management for final disposition.

The Radioactive Waste Management Site at Area 5 is a 732-acre remote radioactive waste storage and disposal facility. Area 5 contains LLW disposal units consisting of pits and shallow trenches. It also provides the Greater Confinement Disposal Unit which consists of a 10-foot diameter shaft 120 feet deep used for experimental disposal of wastes not suited for shallow land burial because of high specific activity or a potential for migration into biopathways. Area 5 also serves as temporary storage for TRU and mixed TRU wastes on a curbed asphalt pad. Approximately 785 cubic yards ($yd^3$) of TRU wastes are stored in 55-gallon drums on pallets and in various assorted steel boxes pending shipment to WIPP.

DOE and the State of Nevada signed a Settlement Agreement on June 23, 1992, regarding alleged violations of storage of mixed TRU waste at NTS. Currently, the Nevada Operations Office plans to retain the existing inventory of mixed TRU waste subject to the permitting of the storage facility. This agreement resolves an alleged violation issued on November 1, 1990, by Nevada Division of Environmental Protection as a result of an August 1990, inspection alleging storage of mixed waste without a permit and lack of proper waste characterization. The agreement also resolves a finding of alleged violation issued on June 24, 1991, alleging an increase in the design capacity of the TRU storage pad without prior state approval. The NTS Waste Analysis Plan, submitted in April 1991, as amended by Nevada Division of Environmental Protection, outlines the characterization procedures to be used as a result of the agreement.

As a result of this Settlement Agreement DOE will:

- Limit mixed TRU waste storage at Area 5 to the current inventory of approximately 743 $yd^3$ (150,000 gallons).
- Obtain a Nevada hazardous waste permit before additional mixed TRU wastes are to be stored at NTS.
- Document why the current inventory of mixed TRU waste cannot be removed until after WIPP becomes operational.
- Report annually on its progress in certifying that the TRU waste stored at NTS meets the WIPP Waste Acceptance Criteria.
- Operate the Area 5 TRU waste storage pad until the waste is removed in accordance with 40 CFR 265, Subpart I.
- Obtain approval for, and construct, a cover for the waste.

A Consent Decree between the State of Nevada and Reynolds Electrical & Engineering Company, Inc., was filed on August 24, 1992, regarding alleged inadequate sampling of pondered received from the Rocky Flats Plant (now known as the Rocky Flats Environmental Technology Site) to be disposed at NTS in the Radioactive Waste Management Site. The resolution was a monetary payment to Nevada and the submission of a schedule for development of a sampling plan for the adequate characterization of the remaining pondered to be disposed at NTS.

The other Radioactive Waste Management Site is the Area 3 Bulk Waste Management Facility which accepts bulk LLW that cannot be packaged for disposal at the Area 5 Radioactive Waste Management Site. Much of the waste material buried there is contaminated soil and metal remaining onsite from the atmospheric testing of nuclear weapons at NTS. The materials are deposited in two waste management units, each consisting of two subsidence craters with the area between the craters excavated to form a large oval disposal unit.

In 1987, a DOE task force determined that underground nuclear device testing areas are subject to the provisions of CERCLA. Under CERCLA all releases of hazardous or extremely hazardous substances that exceed reportable quantities must be reported to the National Response Center. Preliminary Assessment/Site Investigation reports required by CERCLA were prepared for NTS and provided to the EPA in 1988. The contaminants of concern at NTS are the results of historic aboveground and underground testing, the disposal of incidental wastes generated in support of the testing operations, and nuclear rocket experiments. Prior to 1963, soils contaminated during the atmospheric nuclear testing were consolidated and disposed of in fill areas. Soils and equipment contaminated with radionuclides as a result of quillback or tunnel operations were also

disposed of in the drill areas at NTS. The types of possible contaminants found on the surface of NTS include: radionuclides; organic compounds; metals such as beryllium, lead, and hydrocarbons; and residues from plastics, epoxy, and drilling muds used during test boring drilling and instrumentation. Soils contaminated by plutonium are also a concern. EPA will use the revised Hazard Ranking System to determine if any NTS sites are to be included on the NPL. If NTS is placed on the NPL, then DOE anticipates entering into an interagency agreement with the State of Nevada and EPA.

### A.1.3 Oak Ridge Reservation

**Site Description.** ORR consists of approximately 34,700 acres of Federal-owned lands located directly to the west and south, but within the incorporated city limits of Oak Ridge, TN. The city of Oak Ridge and ORR are within the region known as the Great Valley of the Tennessee River, which lies between the Comburant and Southern Appalachian mountain ranges. About 10 miles to the northwest, the Comburant mountains rise to an elevation of 3,000 feet or more while the Great Smoky Mountains National Park reaches to heights over 6,600 feet some 70 miles to the southeast. The largest city in the area, Knoxville, is located approximately 30 miles to the southeast. Land use in the five-county area surrounding ORR varies from the heavily populated and highly developed urban areas around Knoxville, to the sparsely populated areas immediately surrounding ORR. The largest single land use for each of the five counties is forestry; the second most common use is agriculture.

DOE has three primary complexes within ORR. These are the Y-12 Plant (Y-12), the K-25 Site (formerly the Oak Ridge Gaseous Diffusion Plant), and the Oak Ridge National Laboratory. Originally built in the early 1940's for large-scale production of fissionable material for the world's first nuclear weapon, they continue to be used today as research, development, and manufacturing facilities (figure 4.4.1–1 and table 4.4.2.2–1).

Y-12 is situated on 811 acres in the eastern end of ORR in the location known as Bear Creek Valley. Primary missions of Y-12 include dismantling nuclear weapon components returned from the national arsenal, maintaining nuclear production capability and stockpile support, and providing storage for special nuclear materials. Y-12 also supports other federal agencies through a Work for Others program. In addition, a technology transfer program has been established to support the U.S. industrial base by applying Y-12 expertise to a wide range of manufacturing problems. All of the uranium parts used in building U.S. nuclear weapons were fabricated at Y-12. The plant itself consists of 494 buildings containing more than 7 million $ft^2$ of floor space.

Although the primary mission of K-25 has been to provide enriched uranium for U.S. nuclear weapons and, later, an industrial toll enrichment service by which uranium is enriched for use in power reactors around the world, the gaseous diffusion process at K-25 designed for that function was placed in permanent shutdown in 1987, because of a lack of weapons or commercial requirements. Today, K-25 serves as operations center for Environmental Restoration and Waste Management Programs. The Site is also the home of DOE's Center for Environmental Technology and Center for Waste Management.

Oak Ridge National Laboratory programs focus on basic and applied research, technology development, and technology that has been designated important to DOE and the Nation. It also performs work for non-DOE sponsors when such activities complement DOE missions and address significant national or international issues. In addition, Oak Ridge National Laboratory supplies radioactive and stable isotopes that are not available from the private sector.

The 604 buildings on ORR outside Y-12 contain more than 17 million $ft^2$ of floor space. Most of these buildings and structures are located within K-25 or Oak Ridge National Laboratory; however, several buildings and structures owned or leased by DOE are outside ORR. The onsite buildings and structures outside the major plant sites consist of the Scarboro Facility, the Central Training Facility, the Transportation Safeguards Division Maintenance Facility, and some ancillary structures. Most physical facilities used by the various plant protection and security groups are within the primary plant's fenced area; however, the target ranges are outside the fence but within the buffer zones of the main plant areas. Small-arms ranges are located on the east end of Y-12

and north of the west end of Oak Ridge National Laboratory.

The Scarboro Facility, located within ORR and south of Y-12, houses the Oak Ridge Institute for Science and Education's Medical and Health Sciences Division's Large Animal Research Program. The Central Training Facility is shared by the site security force; DOE's Transportation Safeguards Division; and other contractor and agency security personnel. This facility also consists of a small office building, an indoor firing range, classroom and storage trailers, onsite parking, fitness facilities and numerous outdoor firing ranges. The site, located less than a mile southeast of K-25, currently consists of about 140 acres including a buffer area. The Transportation Safeguards Maintenance Facility is the former Stone & Webster warehouse, located about one mile east of K-25.

The offsite buildings and structures consist of the Oak Ridge Operations Office, the DOE Office of Scientific and Technical Information, the Oak Ridge Institute for Science and Education facilities, the American Museum of Science and Energy, the prime contractor's "Townsite" facilities, the National Oceanic and Atmospheric Administration's Atmospheric Turbulence and Diffusion Laboratory, and others. With the exception of the Federal Office Building and space leased from the private sector, all buildings and structures used for DOE functions are situated on DOE-owned land.

**Missions.** The missions of ORR include:

- Maintain capability to fabricate uranium and lithium components and parts for nuclear weapons.
- Store uranium and lithium materials and parts.
- Dismantle nuclear weapons components returned from the stockpile.
- Process uranium, some of which is subject to International Atomic Energy Agency storage.
- Provide support to design agencies as requested.
- Perform waste management and D&D activities at Oak Ridge National Laboratory, Y-12, and K-25.
- Operate the Oak Ridge National Laboratory to perform basic research and development in energy, health, and environment and to produce radioactive and stable isotopes not available elsewhere.
- Sponsor Oak Ridge Institute for Science and Education programs in the areas of health, environment, and energy.
- Perform projects to support other Federal programs.
- Maintain programs to transfer unique technologies developed at Oak Ridge to private industry.
- Perform meteorological and atmospheric diffusion research.

**Facility Operations.** The complexes at ORR are managed by a management and operations contractor, under a contract administered by the Oak Ridge Operations Office. Current missions and functions can be grouped into the following categories: defense program activities; DOE Office of the Assistant Secretary for Environmental Management (EM) activities; other DOE Activities; and non-DOE activities.

*Defense Program Activities.* All defense program activities at ORR are conducted within Y-12. The plant site consists of approximately 811 acres, 630 of which are enclosed by perimeter security fencing and contains 494 buildings or other structures totaling approximately 7 million $ft^2$. The site supports Nuclear Weapons Production and Surveillance and Nuclear Materials Production mission assignments housed in approximately 425 of the 494 buildings and utilizing some 5.4 million $ft^2$ of floor space.

Y-12 missions include dismantling nuclear weapon components returned from the national arsenal, maintaining nuclear production capability and stockpile support, and storing special nuclear materials. Y-12 also stores depleted uranium.

Another important mission of Y-12 is the processing of uranium. Uranium materials are also recovered from the fabrication process and the disassembly of retired weapons. In addition to its functions related to uranium materials, Y-12 performs precision machining and assembles components, provides fabrication support to DOE's weapon design laboratories, and produces components for design evaluation for these customers and most of the test devices used at NTS.

*Other Department of Energy Activities.* Other DOE activities conducted at ORR include missions and programs of K-25, Oak Ridge National Laboratory, Y-12 non-defense programs, the Oak Ridge National Environmental Research Park, the Oak Ridge Institute for Science and Education, and the American Museum of Science and Energy. K-25 contains approximately 1,700 acres and is located six miles northwest of Y-12. The site consists of 250 buildings with approximately 12.2 million $ft^2$ of floor space. The original mission of K-25 was to separate uranium-235 for use in atomic weapons. In December 1987, DOE permanently shut down the gaseous diffusion processes and K-25 was placed on the list of facilities slated for decontamination and decommissioning. Today, K-25 serves as the operations center for Environmental Restoration and Waste Management Programs. It is also the home of DOE's Center for Environmental Technology and Center for Waste Management. Missions and activities include technology development, technology transfer, engineering technology, uranium enrichment support, and the central functions of business management, engineering, computing and telecommunications.

The Oak Ridge National Laboratory complex consists of approximately 2,900 acres located 4 miles southwest of Y-12. The site has approximately 240 buildings containing 2.7 million $ft^2$.

Activities at Oak Ridge National Laboratory include basic and applied research, technology development, and other technology important to DOE and the Nation. Oak Ridge National Laboratory also performs research and development for non-DOE sponsors when such activities complement DOE missions and address significant national or international issues. Missions and activities include energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

Oak Ridge National Laboratory also designs and provides research facilities for the scientific and technical community and supplies radioactive and stable isotopes that are not available from the private sector. Major portions of ORR are used by Oak Ridge National Laboratory in their aquatic habitat, flora, fauna, and other environmental sciences research programs.

In addition to defense program activities described above, Y-12 provides processing of radioactive source materials and support for other government agencies. Some 47 buildings containing 1.5 million $ft^2$ located on Y-12 grounds are utilized by Oak Ridge National Laboratory in support of non-defense program missions. Oak Ridge National Laboratory employs some 450 people at Y-12. Also located on the Y-12 site are approximately 20 buildings containing 300,000 $ft^2$ which house the DOE construction manager, the water plant maintenance contractor for ORR, and several organizations of the Oak Ridge Operations Office. Employment in these activities include 175 in DOE and 550 in construction manager organizations.

The Oak Ridge National Environmental Research Park, established in 1980, consists of 13,590 acres on the ORR. As one of seven DOE research parks, its purpose is to provide protected land areas for research and education in the environmental sciences and to demonstrate that energy technology development is compatible with a quality environment. There are 53 active Environmental Sciences Research Sites consisting of 3,562 acres on ORR. In addition, there are 15 inactive sites on a total of some 323 acres.

Oak Ridge Institute for Science and Education's primary missions are to provide educational and research programs in the areas of health, environment, and energy for DOE, other federal agencies, and private industry. The American Museum of Science and Energy is located at a site contiguous to the Oak Ridge Institute for Science and Education campus. The museum contains historical displays and exhibits about energy in its various forms as well

as topical matter on the growth of the nuclear power industry.

*Non-Department of Energy Activities.* Non-DOE activities pursued at ORR include missions and programs of the National Oceanic and Atmospheric Administration which conducts meteorological and atmospheric diffusion research that is supported by both itself and DOE. This work is done at the Atmospheric Turbulence and Diffusion Laboratory and field sites on ORR. The laboratory also provides services to DOE contractors and operates the Weather Instrument Telemetering Monitoring System for DOE.

**Environmental Regulatory Setting.** ORR consists of three separate sites in and around the city of Oak Ridge; however, all Federal and state environmental agreements deal with ORR as a single entity. The State of Tennessee, which has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste, entered into a five-year Monitoring and Oversight Agreement with DOE on May 13, 1991, to assure Tennessee citizens that their health, safety, and environment are being protected during ORR facility operations. The Tennessee Department of Environment and Conservation is the lead state agency for implementation of this agreement in which DOE provides financial support to allow Tennessee to carry out its commitment under the oversight agreement and the Federal Facility Agreement regarding cleanup activities. In addition, ORR performs its own environmental monitoring of effluents and surveillance of the environmental media to characterize and quantify contaminants, assess radiation exposures of members of the public, demonstrate compliance with applicable standards and permit requirements, and assess the effects, if any, on the local environment. The Oversight Agreement also ensures that DOE complies with all applicable laws, regulations, and orders.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. This section discusses the more important agreements and other regulatory issues that must be considered before making a tritium supply decision that would affect ORR.

On December 21, 1989, EPA placed ORR on the NPL as a "Superfund Site" pursuant to the provisions of CERCLA. This determination was based on the contamination present due to past practices.

*Air.* Regulation of radionuclide air emissions at ORR is governed by the Federal Facility Compliance Agreement for CAA (Rad-NESHAP) signed May 26, 1992, and the Radionuclide NESHAP Compliance Plan for ORR, dated April 17, 1991. The *National Emissions Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H) requires sampling and reporting to demonstrate compliance with the 10 mrem per year effective dose equivalent standard. Continuous emission sampling is required for any emission point with the potential to cause a dose exceeding 0.1 mrem per year. During 1992, 65 of 81 continuously monitored stacks were judged to have the potential to emit radioactive effluents that contribute greater than 0.1 mrem per year effective dose equivalent to an offsite individual. On March 26, 1993, EPA Region IV certified that DOE had completed all of the actions required by the ORR Rad-NESHAP Federal Facility Compliance Agreement and is considered to be in compliance with the Rad-NESHAP regulations. The annual offsite dose to the most-exposed member of the public for ORR was 1.4 mrem in 1992, well below the 40 CFR 61 standard of 10 mrem per year (OR DOE 1993a:xxxviii).

*Water.* A DOE water treatment facility supplies potable water to the city of Oak Ridge and other ORR facilities. The water is treated, chlorinated, and fluoridated before distribution and meets health standards. Activities are underway to reduce discharges of priority pollutants, high temperature water, and toxic agents such as chlorine to the East Fork Poplar Creek. Two dechlorination systems were installed in late 1992, at key outfalls on East Fork Poplar Creek to help control discharges of chlorine from non-contact cooling water systems and to help to eliminate chronic fish kills in the upper reaches of the creek. Additional efforts relating to reducing non-point-source pollutants to surface streams and

cleaning up mercury pollution in the East Fork Poplar Creek are being planned.

NPDES permits are required for each ORR facility. Y-12 is operating at the standards of the permit which expired in May 1990, and submitted a renewal in November 1989, with an addendum submitted in January 1993. Oak Ridge National Laboratory is operating at the standards of the permit which expired in April 1991, and submitted a renewal on October 28, 1990. Oak Ridge National Laboratory submitted a request to the state for modification of its NPDES permit based on evidence that past exceedance of total suspended solids, oil, and grease limits in the past have not impacted watershed water quality. A renewed NPDES permit was issued to K-25 on October 1, 1992, that will eliminate many of the permit exceedances which occurred repeatedly under the expired permit, but were not related to discharges from K-25. The new permit requires monitoring of storm drain discharges into settling ponds and streams, not at the outlets of these streams and ponds as did the expired permit.

Personnel at Y-12 operate a sanitary collection sewer system. Sanitary wastewater is discharged to the city of Oak Ridge under an industrial pretreatment permit. A new monitoring station was completed January 16, 1993, which allows for more accurate monitoring of the sanitary sewage discharges by Y-12. In addition to the sanitary sewer system, ORR submitted individual stormwater permit applications in October 1992, for all three sites, as required by the *Clean Water Act* (CWA) and Tennessee regulations. ORR had been performing extensive sampling since June 1991, in preparation for these applications.

On January 17, 1992, Friends of the Earth, a nonprofit corporation, filed a lawsuit against DOE in Federal District Court in Knoxville, TN. The lawsuit alleges that DOE is violating the NPDES permits because discharges of certain quantities of various pollutants into tributaries of the Clinch River have exceeded the allowable discharge limits of the NPDES permits. Friends of the Earth filed a motion for summary judgement in October 1992, and DOE filed a cross-motion for denial of summary judgement in January 1993.

*Land.* To satisfy the requirement under Section 104 of CERCLA for an interagency agreement, DOE, EPA Region IV, and Tennessee completed a Federal Facility Agreement effective January 1, 1992. The purposes of the Federal Facility Agreement are to: establish a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at ORR in accordance with CERCLA, RCRA, NEPA, appropriate guidance and policy, and Tennessee state law; coordinate future assessments and most of the remedial action activities planned at ORR pertaining to environmental restoration activities under CERCLA with state laws and existing corrective actions required under the RCRA permit issued to DOE for ORR effective on October 25, 1986; minimize the duplication of investigations, analytical work, and documentation; ensure the quality of data management; expedite response actions with a minimum of delay; and achieve a comprehensive remediation of the site. The Agreement also addresses technical standards for new and existing liquid LLW storage tank systems; conduct of remedial investigation/feasibility studies and remedial design/remedial actions in accordance with timetables for sites listed in Appendix E of the Federal Facility Agreement; setting of annual priorities; and provision of responsive guidance by regulators when requested.

ORR facilities are being operated with a combination of RCRA Part B permits and interim status regulations. The RCRA Part B permit applications have been submitted for all of the active storage and treatment units listed on the Part A permit. Some are approved and other Part B applications are still awaiting action by the State of Tennessee. ORR facilities generate hazardous wastes, and personnel operate hazardous waste treatment and storage facilities. However, there are no units actively used for the disposal of hazardous wastes. Closure actions are complete for several previously used hazardous waste disposal units.

DOE declared a moratorium in May 1991, on the shipment of hazardous waste to non-DOE sites to prevent waste, potentially contaminated with radioactive material, from being shipped to a facility which is not licensed to handle radioactive material. Current DOE policy on No Rad Added, which resulted from the moratorium, effectively requires all RCRA hazardous waste generated at ORR (and other DOE facilities) to be managed as mixed waste until ORR Waste Management provides sufficient

evidence to convince an independent review board for each offsite shipment that selected waste streams are free of radioactivity. The No Rad Added policy, therefore, restricts the ability of ORR to ship offsite RCRA hazardous waste generated at ORR facilities. (OR DOE 1993a:xxxix).

DOE and EPA signed a Federal Facility Compliance Agreement effective June 12, 1992, covering concerns related to the RCRA land disposal restrictions. This Agreement recognizes that DOE is currently storing and will continue to generate and store hazardous wastes, including mixed wastes which contain a hazardous waste component, subject to land disposal restrictions: solvent waste, California list waste, and Third Thirds waste. The agreement requires DOE to submit for EPA review a plan for a waste minimization program at ORR that provides for segregation of hazardous wastes from mixed wastes, substitution of nonhazardous solvents for hazardous solvents where technically practicable, and the minimization of the generation of hazardous waste throughout ORR. In addition to agreeing to implement the waste minimization program, DOE agreed to submit the following additional plans to EPA for review and approval: storage of the land disposal prohibited wastes identified in the Federal Facility Compliance Agreement; the treatment method, facility, and schedule for treating the land disposal prohibited wastes with identified existing treatment; the strategy for conducting treatability studies, technology development, and prioritization of treatment method options for land disposal prohibited wastes without identified existing treatment; and the treatment method, facility and a schedule for the completion of such treatment for wastes without identified existing treatment. This last plan is required not later than March 1995. The RCRA-Land Disposal Restrictions Federal Facility Compliance Agreement and the information provided in the required plans would form the basis for the site-specific mixed waste treatment plan required by the *Federal Facility Compliance Act* of 1992, for DOE facilities storing mixed wastes.

The ORR underground storage tank program regulates approximately 80 tanks and includes some that are deferred or exempt from external regulation. The tanks store petroleum and hazardous substances. ORR is ahead of its schedule for upgrading and/or replacing the underground storage tanks to implement leak detection, spill and overflow protection, and corrosion protection on all regulated tanks by 1998.

ORR facilities have PCBs from past practices and continue to generate PCB-contaminated wastes. These wastes are either shipped to a commercial disposal site, or if contaminated with uranium, stored until the TSCA Incinerator at K-25, which began operations in 1990, can process the waste. Some PCB-contaminated wastes have been stored in excess of one year due to: specific constituents in the waste that render it unacceptable at the TSCA incinerator; the burn priority at the incinerator; or the use of other treatment methods.

TSCA requires PCB-contaminated wastes to be disposed of within one year of its initial placement in storage. Due to its radioactive nature, treatment and disposal technology does not exist for most of these wastes. DOE has an aggressive program to develop this technology, but until it is available, these PCB-contaminated wastes must be safely stored, although not in compliance with TSCA. On June 11, 1992, DOE formally requested negotiation of a Federal Facility Compliance Agreement with EPA which would allow development of an ORR treatment and disposal schedule for radioactive PCB-contaminated waste and storage or disposal per the Agreement.

### A.1.4 Pantex Plant

**Site Description.** Pantex is located in the panhandle of Texas in Carson County. It is about 17 miles northeast of downtown Amarillo (population 157,600) and 40 miles southwest of Pampa (population 19,900). The plant is located on a 16,000-acre portion of the former Pantex Army Ordnance Plant. Pantex was constructed in the first half of the 1940's by the U.S. Army for the production of conventional ordnance. At the end of World War II, the plant was deactivated and the property eventually reverted to the War Assets Administration. In 1949, the entire installation was sold to Texas Technological College (now Texas Technological University) for one dollar. The land was to be used for experimental farming, but was subject to recall under the National Security Clause. Following an extensive survey of World War II ordnance plants, Pantex was chosen in 1951, by the Atomic Energy Commission for expansion of its nuclear weapons assembly facilities. The Army

Ordnance Corps reclaimed the site for the Atomic Energy Commission and contracted a civilian contractor to rehabilitate it.

Pantex consists of 425 buildings containing approximately 2,500,000 $ft^2$ of floor space. Within the 16,000 acres, approximately 2,000 acres are dedicated to active facility operations. Approximately 8,080 acres are devoted to storage, disposal, and miscellaneous activities in support of plant operations. The remainder of the plant site, or about 5,800 acres, is leased from Texas Tech University to provide a Government-controlled safety and security zone on the south side of the facility. The buffer zones are used by Texas Tech University for agricultural research with some acreage leased for private farming. An additional 1,080 acres northeast of the facility provide supplemental water rights and include a lake formerly used for the disposal of treated sewage effluent. Plant acreage also contains some 47 miles of paved roads, 17 miles of railroad tracks, 67 miles of fence, and 4 playa lakes. All the land within a 3-mile radius of the plant site is used for agricultural purposes, either farming or grazing. Approximately 2,000 people live within eight kilometers (five miles) of the outside boundary of Pantex. A significant population concentration occurs southwest of the Pantex facility near the Amarillo International Airport and includes the Texas State Technical Institute and the Highland Park Village. Highland Park Village consists of 500 single- and multiple-family housing units (duplexes) with an occupancy rate averaging about 90 percent. Approximately 100 students are housed in a Texas State Technical Institute student dormitory.

The main mission of Pantex is the manufacture of HE components and the assembly and disassembly of nuclear weapons. Activities in support of the mission are conducted in portions of the facility referred to as zones. The major zones are shown in figure 4.5.1–1 and Pantex baseline characteristics are summarized in table 4.6.2.2–1.

Almost 3,000 personnel support Pantex's mission. This includes area office personnel from DOE, Sandia National Laboratories, New Mexico, employees actively working in quality evaluation, the Courier Section personnel tasked with weapon transportation, and contractor employees that operate the plant. Plant operation includes Direct and Support Manufacturing Operations, Management and Administrative Services, Protective Services, and Maintenance and Utilities. During normal operations, some 600 people are assigned primarily to the Zone 12 South Material Access Area. Approximately half of these individuals routinely handle the radioactive components that are used in weapon production. The Material Access Area is a highly restricted area where special nuclear materials are staged and assembled.

**Missions.** Pantex missions include:

- Manufacture HE components for use in nuclear weapons.
- Assemble new nuclear weapons.
- Retrofit, maintain, and repair nuclear weapons in the stockpile.
- Provide quality assurance evaluations of nuclear weapon systems.
- Assemble nuclear weapon-like devices for testing and training programs.
- Disassemble nuclear weapons for disposal or maintenance purposes.
- Dismantle nuclear weapons no longer required.
- Provide development support to weapons design agencies as requested.
- Store strategic reserve quantities of plutonium.

**Facility Operations.** DOE directs all operations conducted at Pantex. Current missions and functions can be grouped into broad categories of defense program and environmental management activities. No other missions or functions are expected to be added or removed except as described in section 4.5.1 under tritium supply and recycling alternatives for Pantex.

*Defense Program Activities.* The main missions of Pantex are the manufacture of HE components and the assembly/disassembly and maintenance of

nuclear weapons. As previously stated, activities in support of the mission are conducted in portions of the facility referred to as zones. The principal operations performed at Pantex are the assembly of nuclear weapons from components received from other DOE facilities; fabrication of chemical HE components for nuclear weapons; operation of the chemical HE synthesis and characterization group; surveillance testing and disposal of chemical HE; disassembly of obsolete nuclear weapons for retirement; and maintenance, modification, repair, and nonexplosive testing of nuclear weapons components. Weapons assembly and stockpile surveillance activities involve handling significant quantities of uranium components, plutonium components, and tritium components, as well as a variety of nonradioactive toxic chemicals. Brief descriptions of all the above mission activities follow.

HE component production includes manufacturing main charge subassemblies and mock components for use in weapon test assemblies, manufacturing small HE components, producing a variety of explosive materials from chemical reactants and commercially-produced explosives, and evaluating explosive materials and components through a variety of analytical, mechanical, and explosive tests.

New production is defined as the final assembly of a new nuclear weapon to be added to the stockpile. Pantex receives weapons components and other materials from throughout the Complex. The first step in the new production process is the mating of the HE main charge subassemblies and the special nuclear materials, which takes place within an assembly cell. Assembly bays house the remainder of the assembly process. This is where the nuclear subassembly produced in the assembly cell is built into a complete weapon. After final assembly, the items produced at Pantex are shipped either to other facilities within the DOE Complex or to military facilities by truck.

The tasks of modification, maintenance, and repair involve the disassembly of a stockpiled nuclear weapon so that one or more of the components can be repaired, replaced, or modified. After replacing the components, the weapon is reassembled and returned to the stockpile. Activities of this type can be placed into one of the following categories:

- Major Modification—Replacement or modification of such components as the HE charges, the firing sets, or the electrical subassemblies.

- Limited Life Component Exchange—Parts that must be periodically replaced. Some systems require extensive disassembly to accomplish this task. Pantex is responsible for disassembling these weapons, replacing the limited life component and returning the weapons to the stockpile.

- Repairs—Weapons that have sustained damage. An example of such repair is the replacement of mechanical or electrical parts damaged by military users in field locations.

Pantex performs many quality assurance evaluation activities on both new and stockpiled nuclear weapons. These tests involve the disassembly of a weapon, the laboratory testing of various components, and the rebuilding of the weapon for shipment back to the stockpile. Five evaluations are performed at Pantex: New Material Laboratory Testing, New Material Flight Testing, Stockpile Laboratory Testing, Stockpile Flight Testing, and Accelerated Environmental Aging and Materials Compatibility Testing. These evaluations are outlined below:

- New Material Laboratory Testing—Disassembly of a randomly selected newly-produced weapon before it is shipped to the stockpile. Various components are subjected to either destructive or nondestructive tests. After testing, the weapon is rebuilt and shipped to the stockpile.

- New Material Flight Testing—Similar to New Material Laboratory Testing. Units are selected at random before delivery to the stockpile and may be assembled into a nonnuclear, usually nonexplosive, joint test assembly for flight testing. These assemblies are tested aboard aircraft to verify the functioning of the components under in-flight conditions. After the test flight, the unit is returned to Pantex for further examination when possible.

- Stockpile Laboratory Testing—Similar to the New Material Laboratory Testing, but with two major differences. First, Stockpile Laboratory Testing is performed on units randomly selected from the stockpile. Second, some weapons selected for Stockpile Laboratory Testing are not rebuilt after the test, but are disassembled and the components destructively tested to ensure that DOE has an accurate estimate of system reliability.

- Stockpile Flight Testing—Has characteristics of both Stockpile Laboratory Testing and New Material Flight Testing. Components from the selected stockpiled unit are assembled into a joint test assembly for in-flight testing, and undergo similar post-test examination.

- Accelerated Environmental Aging and Material Compatibility—Determines the effects of aging on the integrity of weapon systems over time. These tests involve subjecting newly-produced units to an artificial aging process or to environmental stresses to determine whether or not they retain their chemical and physical properties, and to ensure that they will react in a predictable manner after an extended period of time.

Also, some testing is performed at the Gas Analysis Laboratory, which evaluates samples taken from accelerated aging units, material compatibility tests, development activities, material certification tests, and production operations.

Nuclear weapons no longer needed in the stockpile must be disassembled and disposed of; Pantex accomplishes this in one of the following ways:

- Quality Assurance Disposal—Weapons selected for Stockpile Laboratory Testing that are not to be rebuilt are disposed of. After the parts selected for testing have been removed, the remaining portion of the weapon is disassembled and the parts disposed of after component testing.

- Dismantlement Surveillance—Units selected for disposal in this manner are completely disassembled and selected parts subjected to testing.

- Dismantlement—Dismantlement activities consist of the disassembly of a weapon and the disposition (i.e., staging or destruction) of the components. Limited quality testing and evaluations may be performed.

In addition to the primary efforts associated with weapons assembly/disassembly, disposal, and quality assurance, Pantex provides development support and services to the nuclear weapon design agencies and to other government entities, as requested.

Pantex contains a number of facilities that stage (i.e., temporarily store) weapon components that are destined either for the assembly cells or for shipment back to other DOE facilities. Staging procedures may involve the leak testing of staging containers, inventory procedures to verify the number and contents of containers, and unpacking and repacking to physically verify and test contents.

Assembly and disassembly activities are conducted in Zone 12. There are special nuclear materials staging areas, HE staging and production areas, and component warehouses in Zone 12. Other Zone 12 activities include electrical component testing at the Sandia Systems Test Laboratory located there, as well as administrative office functions, craft shops, the command center, fire station, and other general support facilities such as the cafeteria and sewage treatment.

Stockpile maintenance, testing, disassembly, and disposal missions are conducted in Zones 5 and 12. Zone 4 West is used for staging of weapons and special nuclear materials and interim storage of plutonium pits. Zone 4 East is used for staging of HE and other material. Additional sources of support to the Pantex mission include warehousing and landfill operations in Zone 10, water wells and a water treatment plant in Zone 15, and a vehicle maintenance facility in Zone 16.

The HE development area in Zone 11 consists of facilities for synthesizing and characterizing new HE. HE and HE scrap are disposed of onsite at the burning grounds. The test firing site has several reinforced concrete bunkers containing control rooms and camera areas. Experimental HE configurations are detonated on firing pads surrounded by earthen bunkers. Selected samples of HE components are detonated for quality assurance testing.

*Other Department of Energy Activities.* At present, no other DOE activities are pursued at Pantex.

*Non-Department of Energy Activities.* At present, there are no non-DOE activities pursued at Pantex.

**Environmental Regulatory Setting.** In 1989, the Secretary of Energy invited the host state of each DOE facility to independently determine and verify any plant operational impacts to the environment. In response to this initiative, DOE entered into an Agreement-in-Principle with the State of Texas to focus on waste management, emergency response, and environmental monitoring. DOE provides required information to the State of Texas, and the State conducts sampling and research activities. DOE also issued a Grant-in-Aid for hydrogeologic characterization studies at Pantex.

On September 1, 1993, the Texas legislature created the Texas Natural Resources Conservation Commission and transferred to it the responsibilities of the Texas Water Commission and merged the Texas Air Control Board into the new agency. This agency is now organized to include the Office of Water Resource Management, Office of Air Quality, and Office of Waste Management, among others. Pantex provides office space for Commission officials who are assigned to the plant. EPA has delegated to the State of Texas regulatory authority for air and solid and hazardous waste.

The Department is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at Pantex. The Department is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements, and financial penalties for nonachievement of agreed upon milestones. On May 31, 1994, EPA placed Pantex on the NPL as a "Superfund Site" pursuant to the provisions of CERCLA. This determination was based on the contamination present due to past practices.

*Air.* The emission of radionuclides from Pantex is regulated under the *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities* (40 CFR 61, Subpart H) by EPA. The standard is that level of emissions of radionuclides that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem or less. The effective dose equivalent to any member of the public from emissions of radionuclides from Pantex in 1993 was less than 1 percent of 10 mrem. To demonstrate compliance with the 40 CFR 61 standard, Pantex performed periodic confirmatory monitoring as prescribed in 40 CFR 61.93 for DOE facilities that emit less than 1 percent of the 10 mrem per year allowable limit.

The Burning Ground, where explosives, explosive components, and explosive-contaminated materials are demilitarized as required by the *Atomic Energy Act,* operates as a RCRA Interim Status Unit and under a written grant of authority from the Texas Natural Resources Conservation Commission. The Burning Ground is also used to thermally treat explosive waste and explosive-contaminated waste. The Texas Natural Resources Conservation Commission has indicated its desire to modify the provisions of this authority. Discussions on the terms of the proposed permit modification between the State of Texas, DOE, and parties to the hearing process are ongoing.

*Water.* The city of Amarillo operates a major water supply well field immediately north and down gradient of Pantex. Pantex also receives its drinking water from the Ogallala aquifer via five groundwater wells located on the northeast corner of the plant. The water is treated onsite and tested in accordance with requirements for public drinking water systems. The domestic water supply at Pantex meets all of the national primary and secondary drinking water standards for non-community, nontransient public water supply systems. On December 20, 1992, Texas Natural Resources Conservation Commission representatives inspected the domestic water supply

system at Pantex. The inspection revealed that the system is being operated and maintained in compliance with Texas statutes and regulations.

Onsite monitoring wells, installed in 1990 between the former chemical burn pit and the Amarillo/Pantex water supply, have not detected any contamination. Other onsite monitoring wells have detected contamination in the upper level or perched aquifer. Pantex no longer releases aqueous waste streams containing hazardous waste or hazardous waste constituents to the land surface. EPA issued DOE a RCRA Administrative Order on Consent effective December 10, 1990, requiring Pantex to conduct a RCRA Facility Investigation to identify, assess, and correct actual and potential threats to human health or the environment resulting from the release or potential release of hazardous wastes or constituents at the facility. DOE completed the RCRA facility investigation and has completed Phase I on 8 work plans and Phase II on one work plan.

In response to a request by the DOE, the EPA determined that an NPDES permit was applicable to operations conducted at Pantex. HE-contaminated wastewater is filtered and treated at individual building filter systems. Most of the filtered water flows into the wastewater lagoon. Since 1980, pursuant to the Texas Water Code, the Texas Natural Resources Conservation Commission has permitted Pantex to discharge its wastewater under a no discharge wastewater permit (Permit Number 02296). No discharge permits allow wastewater discharges not going to "waters of the State." In 1980, the state did not consider playas to be "waters of the State." On December 26, 1990, the DOE filed a permit application to modify its permit. The permit application was resubmitted in May 1992, at the request of the Texas Natural Resources Conservation Commission to change the permit from a no discharge to a discharge permit.

*Land.* Pantex is registered with the State of Texas (Texas Natural Resources Conservation Commission Solid Waste Registration Number 30459) and operates under a hazardous waste permit HW-50284 and EPA Identification Number TX4890110527. Pantex currently operates units both under its hazardous waste permit and under interim status. On April 25, 1991, the Texas Natural Resources Conservation Commission and EPA issued a permit to Pantex to store containers and tanks and to treat hazardous waste in tanks. The permit specifically excluded 17 RCRA units at the Burning Ground, but continued the interim status of those units. Pantex thermally treats explosive waste and explosive-contaminated waste at the Burning Ground. The Burning Ground operates as a RCRA Interim Status Unit and under a written Grant of authority from the Texas Natural Resources Conservation Commission. In November 1991, the DOE formally submitted a request to the Texas Natural Resources Conservation Commission for a Class 3 Modification to add the units at the Burning Ground to the permit. Pursuant to the public notice published on October 31, 1991, interested parties requested a hearing before a hearing examiner on the permit. On May 31, 1992, the Texas Natural Resources Conservation Commission Office of Air Quality, recommended draft hazardous waste permit provisions for the Burning Ground. The Texas Natural Resources Conservation Commission, the DOE, and parties to the hearing process are continuing discussions on terms of the proposed permit modification.

Pursuant to the requirements of the *Federal Facility Compliance Act* of 1992, DOE prepared and submitted to the EPA and Texas Natural Resources Conservation Commission an inventory of all mixed waste stored at Pantex on April 23, 1993. Pantex also submitted a Conceptual Site Treatment Plan to the Texas Natural Resources Conservation Commission in October 1993, as required by the *Federal Facility Compliance Act* of 1992. The Final Site Treatment Plan is to be submitted to the State of Texas by October 1995.

One area of alleged noncompliance resulting from the Texas Natural Resources Conservation Commission RCRA inspection in July 1992, is the storage of mixed waste for a period greater than one year, which is prohibited by the land disposal restrictions. Pantex is addressing the issue of mixed waste storage in its Site Treatment Plan as required by the *Federal Facility Compliance Act* of 1992. The Pantex solution will be finalized in late 1995 upon acceptance by the state of the Site Treatment Plan and state agreement to a resulting Consent Order.

As of December 31, 1993, all equipment and parts used at Pantex that contained PCBs had concentrations of less than 50 parts per million (ppm); thus,

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DOE/EIS-0161

# Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling

## Executive Summary

DOE/EIS 04e

United States Department of Energy
Office of Reconfiguration

February 1995

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**Department of Energy**
Washington, DC 20585

Dear Interested Party:

The Draft Programmatic Environmental Impact Statement (PEIS) for Tritium Supply and Recycling has been completed. A public comment period will extend through May 15, 1995.

Tritium, a radioactive gas used in all of the Nation's nuclear weapons, has a short half-life and must be replaced periodically in order for the weapon to operate as designed. Currently, the Nation has no tritium production capability.

The Tritium Supply and Recycling PEIS evaluates the alternatives for the siting, construction, and operation of tritium supply and recycling facilities at each of five candidate sites: the Idaho National Engineering Laboratory, the Nevada Test Site, the Oak Ridge Reservation, the Pantex Plant, and the Savannah River Site. Alternatives for new tritium supply and recycling facilities consist of four different tritium supply technologies; Heavy Water Reactor, Modular High Temperature Gas-Cooled Reactor, Advanced Light Water Reactor, and Accelerator Production of Tritium. The PEIS also evaluates the impacts of using a commercial light water reactor, either as a contingency in the event of a national emergency or if purchased by the Department and converted to defense purposes. Additionally, the PEIS includes an analysis of multi-purpose reactors which would produce tritium, dispose of plutonium and produce electricity.

All interested parties are invited to submit comments by regular mail, by calling the Tritium Supply and Recycling toll free number at 1-800-776-2765, or electronically via computer with a modem or through Internet. For information on mailing comments or sending them electronically, please call the toll free number. Public hearings on the Draft PEIS are scheduled to begin April 5 and run through April 20, 1995. Specific information regarding these hearings can also be obtained by calling the above toll free number.

Sincerely,

Stephen M. Sohinki
Director
Office of Reconfiguration

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# Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling

## Executive Summary

United States Department of Energy
Office of Reconfiguration

February 1995

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# Acronyms

| | |
|---|---|
| APT | Accelerator Production of Tritium |
| ALWR | Advanced Light Water Reactor |
| CEQ | Council on Environmental Quality |
| DOE | Department of Energy |
| DP | DOE Office of the Assistant Secretary for Defense Programs |
| ES&H | environment, safety, and health |
| HLW | high-level waste |
| HWR | Heavy Water Reactor |
| INEL | Idaho National Engineering Laboratory |
| IP | implementation plan |
| LLW | low-level waste |
| MHTGR | Modular High Temperature Gas-Cooled Reactor |
| NEPA | *National Environmental Policy Act* of 1969 |
| NRC | Nuclear Regulatory Commission |
| NRHP | National Register of Historic Places |
| NTS | Nevada Test Site |
| ORR | Oak Ridge Reservation |
| PEIS | programmatic environmental impact statement |
| ROD | Record of Decision |
| SRS | Savannah River Site |
| TRU | transuranic |

# EXECUTIVE SUMMARY

## INTRODUCTION

In January 1991, the Secretary of Energy announced that the Department of Energy (DOE) Office of the Assistant Secretary for Defense Programs (DP) would prepare a programmatic environmental impact statement (PEIS) examining alternatives for the reconfiguration of the Nation's Nuclear Weapons Complex (Complex). The framework for the Reconfiguration PEIS was described in the January 1991 *Nuclear Weapons Complex Reconfiguration Study*, a detailed examination of alternatives for the future Complex. Because of the significant changes in the world since January 1991, especially with regard to projected future requirements for the United States nuclear weapons stockpile, the framework described in the *Nuclear Weapons Reconfiguration Study* does not exist today. Therefore, the Department separated the Reconfiguration PEIS into two PEISs: a Tritium Supply and Recycling PEIS; and a Stockpile Stewardship and Management PEIS. The Tritium Supply and Recycling Action is analyzed in this PEIS. Once formulated, the Stockpile Stewardship and Management Proposal will be analyzed in a PEIS in 1995.

Another issue which was once part of reconfiguration was the storage of all weapons-usable fissile materials, primarily highly enriched uranium and plutonium. In 1994, the DOE established a separate office within the Department to address not only the storage but the disposition of excess weapons-usable fissile material. As a result of this, a third PEIS, the Storage and Disposition of Weapons-Usable Fissile Materials PEIS, is being prepared to analyze alternatives for the long-term storage of all weapons-usable fissile materials, primarily highly-enriched uranium and plutonium. This PEIS will also address the disposition of these materials declared surplus to national defense needs by the President.

## TRITIUM SUPPLY AND RECYCLING PROPOSAL

DOE proposes to provide tritium supply and recycling facilities for the Complex. Tritium, a man-made radioactive isotope of hydrogen, is an essential component of every warhead in the current and projected U.S. nuclear weapons stockpile. These warheads depend on tritium to perform as designed. Tritium decays at 5.5 percent per year and must be replaced periodically as long as the Nation relies on a nuclear deterrent. Currently, there is no capability to produce tritium within the Complex (figure ES–1), yet projections require that new tritium be available by approximately 2011. The *Tritium Supply and Recycling Programmatic Environmental Impact Statement* evaluates the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at each of five candidate sites: the Idaho National Engineering Laboratory (INEL), Nevada Test Site (NTS), Oak Ridge Reservation (ORR), the Pantex Plant, and the Savannah River Site (SRS). The PEIS assesses the environmental impacts of all reasonable alternatives discussed below, including No Action.

**Tritium Supply and Recycling Proposal:**

- **Provide the long-term, assured supply of tritium.**
- **Safely and reliably fulfill all future national defense requirements for tritium.**
- **Protect the health of workers, the general public, and the environment.**

Tritium supply deals with the production of new tritium in either a reactor or an accelerator (by irradiating target materials with neutrons) and the subsequent extraction of the tritium in pure form for its use in nuclear weapons. Tritium recycling consists of recovering residual tritium from weapons components, purifying it, and refilling weapons components with both recovered and new tritium when it becomes available.

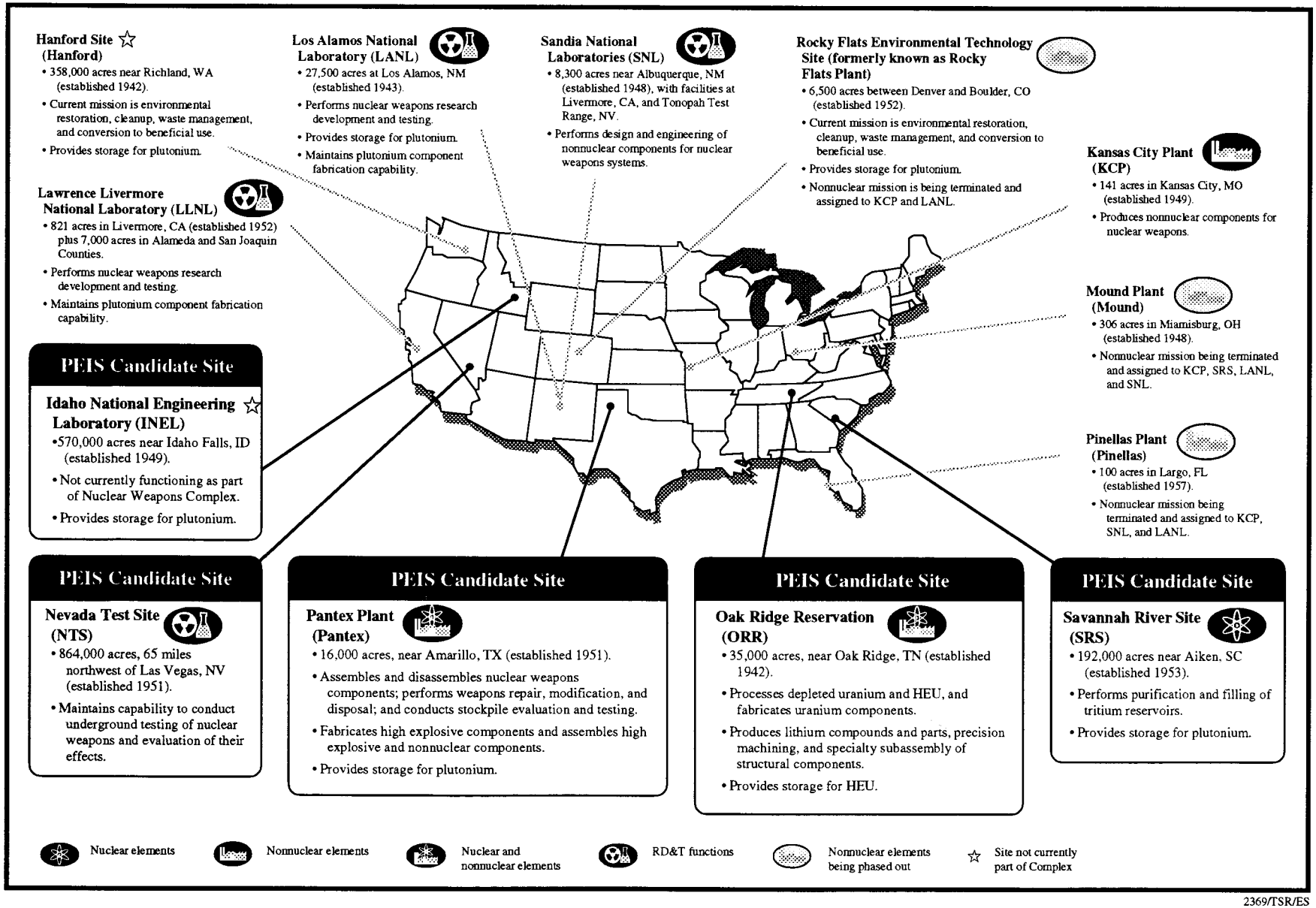


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**FIGURE ES–1.**—*Nuclear Weapons Complex Sites.*

Under No Action, DOE would not establish a new tritium supply capability. The current inventory of tritium would decay and DOE would not meet stockpile requirements of tritium. This would be contrary to DOE's mission as specified by the *Atomic Energy Act* of 1954, as amended. Alternatives for new tritium supply and recycling facilities consist of four different tritium supply technologies and five locations as shown in figure ES–2. The four technologies proposed to provide a new supply of tritium are Heavy Water Reactor (HWR), Modular High Temperature Gas-Cooled Reactor (MHTGR), Advanced Light Water Reactor (ALWR), and Accelerator Production of Tritium (APT). Both Large (1300 MWe) and Small (600 MWe) options for the ALWR are evaluated as well as a phased approach for the APT. Also analyzed is the use of an existing commercial light water reactor that would be purchased and converted for tritium production.

Additionally, the Tritium Supply and Recycling PEIS includes an assessment of the environmental and institutional impacts associated with using one or more commercial light water reactors for tritium production as a contingency in the event of a national emergency. This contingency option would permit the commercial reactor to continue normal electricity generation. Specific commercial reactors are not identified in the PEIS.

This PEIS also addresses the environmental impacts of an ALWR or modular gas-cooled reactor used as a multipurpose reactor. A multipurpose ("triple play") reactor is defined as one capable of producing tritium, "burning" plutonium, and generating revenues through the sale of electric power. The multipurpose ALWR would operate essentially the same as the uranium-fueled tritium production ALWR. Therefore, the environmental impacts from operation of a multipurpose ALWR would be expected to be unchanged from the tritium production ALWR. However, a plutonium pit disassembly/conversion/mixed-oxide fuel fabrication facility would be needed to provide the mixed-oxide fuel rods for the ALWR multipurpose reactor, and would be the major contributor to potential environmental impacts for this scenario. For a modular gas-cooled multipurpose reactor, twice as many reactor modules would be needed both to meet tritium requirements and to burn plutonium. A plutonium pit disassembly/conversion/fuel fabrication facility would also be needed. Thus, the potential environmental impacts for a multipurpose gas-cooled reactor are expected to be substantially greater than a uranium-fueled tritium production gas-cooled reactor.

**Time Frame of Proposed Action:**

- **1999 to 2009—Construction.**
- **2010 Initial Operation.**
- **2010 to 2050—Full Operation.**

The Tritium Supply and Recycling Proposal will proceed in three phases. The first phase involves preparing information to support programmatic decisions on siting and technology. This includes preparing this PEIS and the associated Record of Decision (ROD). The ROD may include the following programmatic decisions:

- Whether to build new tritium supply and new or upgraded tritium recycling facilities;
- Where to locate tritium supply and recycling facilities;
- Which technology to employ for tritium supply.

During the second phase, DOE will develop detailed designs and meet project-specific *National Environmental Policy Act* of 1969 (NEPA) requirements which would focus on where the facility would be placed and construction and operation impacts. The third phase will involve constructing, testing, and certifying the selected tritium supply and recycling facilities, leading to full operation. Present planning, depending on funding levels, requires the tritium facilities to be fully operational by the year 2010 with new tritium available for use approximately 1 year later.

Following the PEIS, DOE will develop a schedule for implementing the ROD decision. The schedule will be subject to change and include reassessments required by congressional authorizations and

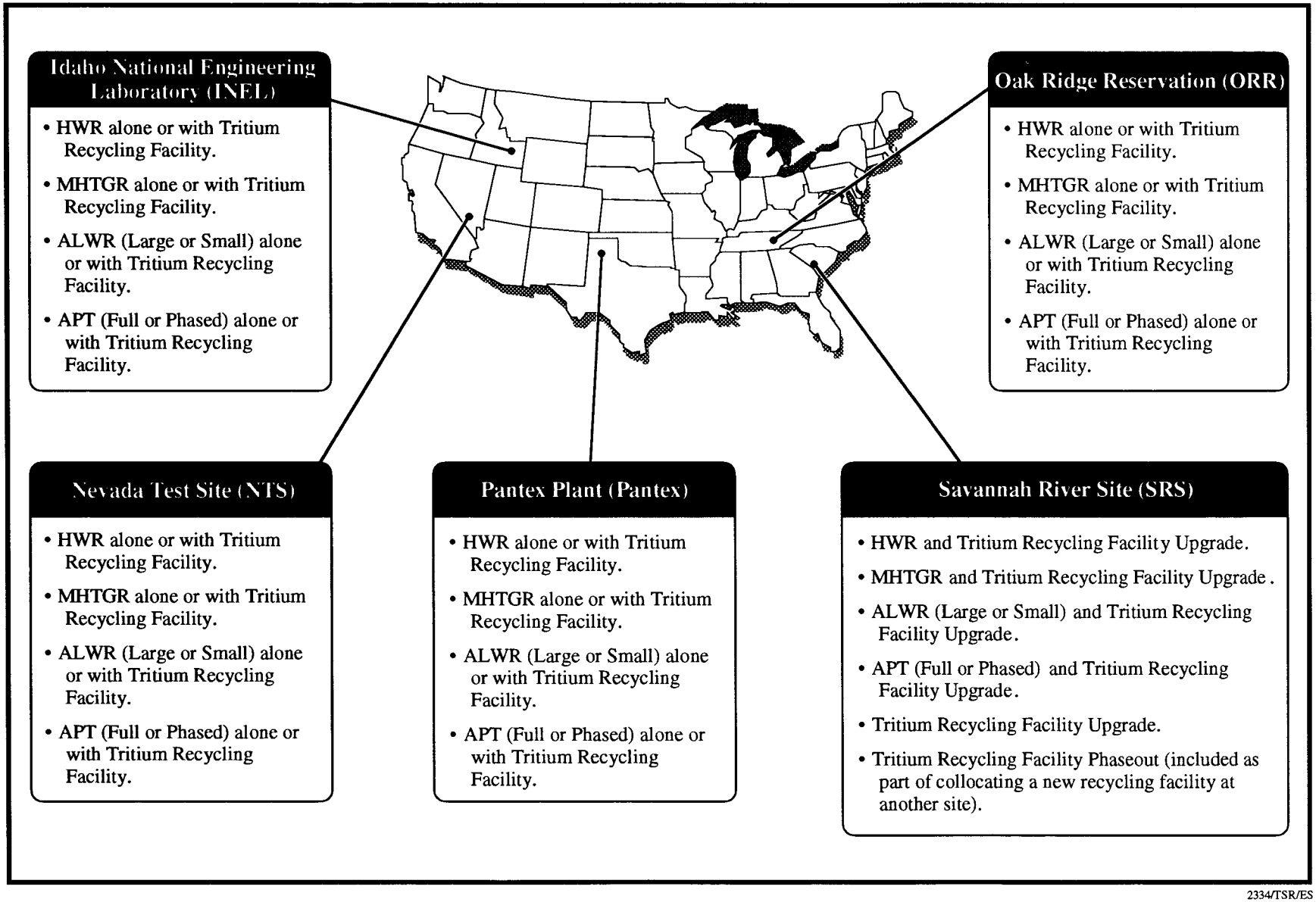


**FIGURE ES–2.**—***Tritium Supply and Recycling Alternatives.***

appropriations. Although the individual schedules of any activities or projects may overlap, the current uncertainty associated with any given activity or project requires that assumptions be made regarding the time periods used in the PEIS analyses.

Because of the uncertainties associated with the scheduling of the second and third phases, the PEIS assumes an environmental baseline period for construction between 1999 and 2009, and an operational period, beginning in approximately 2010, of 40 years. Although the design life of the tritium supply and recycling facilities has not yet been determined by engineering studies, the assumption of an operational period of approximately 40 years is consistent with the operating periods used in prior DOE NEPA documents for similar new facilities. Project-level tiered NEPA documents would identify in detail the specific construction and operational periods for each project implemented.

## PURPOSE OF AND NEED FOR THE DEPARTMENT OF ENERGY'S ACTION

Since nuclear weapons came into existence in 1945, a nuclear deterrent has been a cornerstone of the Nation's defense policy and national security. The President reiterated this principle in his July 3, 1993, radio address to the Nation. Tritium is used to enhance the yield of nuclear weapons and allows for the production of smaller or more powerful weapons. The United States has based its strategic nuclear systems on designs that use tritium and therefore requires a reliable supply source. Tritium has a relatively short radioactive half-life of 12.3 years. Because of this relatively rapid radioactive decay, tritium must be replenished periodically in nuclear weapons to ensure that they will function as designed. Over the past 40 years, DOE has built and operated 14 reactors to produce tritium and other nuclear materials. Today, none of these reactors are operational, and no tritium has been produced since 1988.

**Tritium, with a 12.3-year half-life, decays at the rate of approximately 5 percent per year and is necessary for all nuclear weapons that remain in the stockpile.**

Pursuant to the *Atomic Energy Act* of 1954, as amended, DOE is responsible for developing and maintaining the capability to produce nuclear materials such as tritium, which are required for the defense of the United States. The primary use of tritium is for maintaining the Nation's stockpile of nuclear weapons as directed by the President in the Nuclear Weapons Stockpile Plan. Figure ES–3 depicts the Nuclear Weapons Stockpile Plan process.

The Nuclear Weapons Stockpile Plan is forwarded annually from the Secretaries of the Departments of Energy and Defense via the National Security Council to the President for approval. The Nuclear Weapons Stockpile Plan reflects the size and composition of the stockpile needed to defend the United States and provides an assessment of the DOE ability to support the proposed stockpile. Many factors are considered in the development of the Nuclear Weapons Stockpile Plan, including the status of the currently approved stockpile, arms control negotiations and treaties, Congressional constraints, and the status of the nuclear material production and fabrication facilities. Revisions of the Nuclear Weapons Stockpile Plan could be issued when any of the factors indicate the need to change requirements established in the annual document. The current Nuclear Weapons Stockpile Plan, which was approved by President Clinton on March 7, 1994, authorizes weapons production and retirement through fiscal year 1999. The analysis in this PEIS is based on the requirements of the Nuclear Weapons Stockpile Plan. Appendix CA, which is classified, contains quantitative projections for tritium requirements based on the 1994 Nuclear Weapons Stockpile Plan, and details of the transportation analysis.

Even with a reduced nuclear weapons stockpile and no identified requirements for new nuclear weapons production in the foreseeable future, an assured long-term tritium supply and recycling capability will be required. Presently, no source of new tritium is available. The effectiveness of the U.S. nuclear deterrent capability depends not only on the Nation's current stockpile of nuclear weapons or those it can produce, but also on its ability to reliably and safely provide the tritium needed to support these weapons.

Until a new tritium supply source is operational, DOE will continue to support tritium requirements by recycling tritium from weapons retired from the

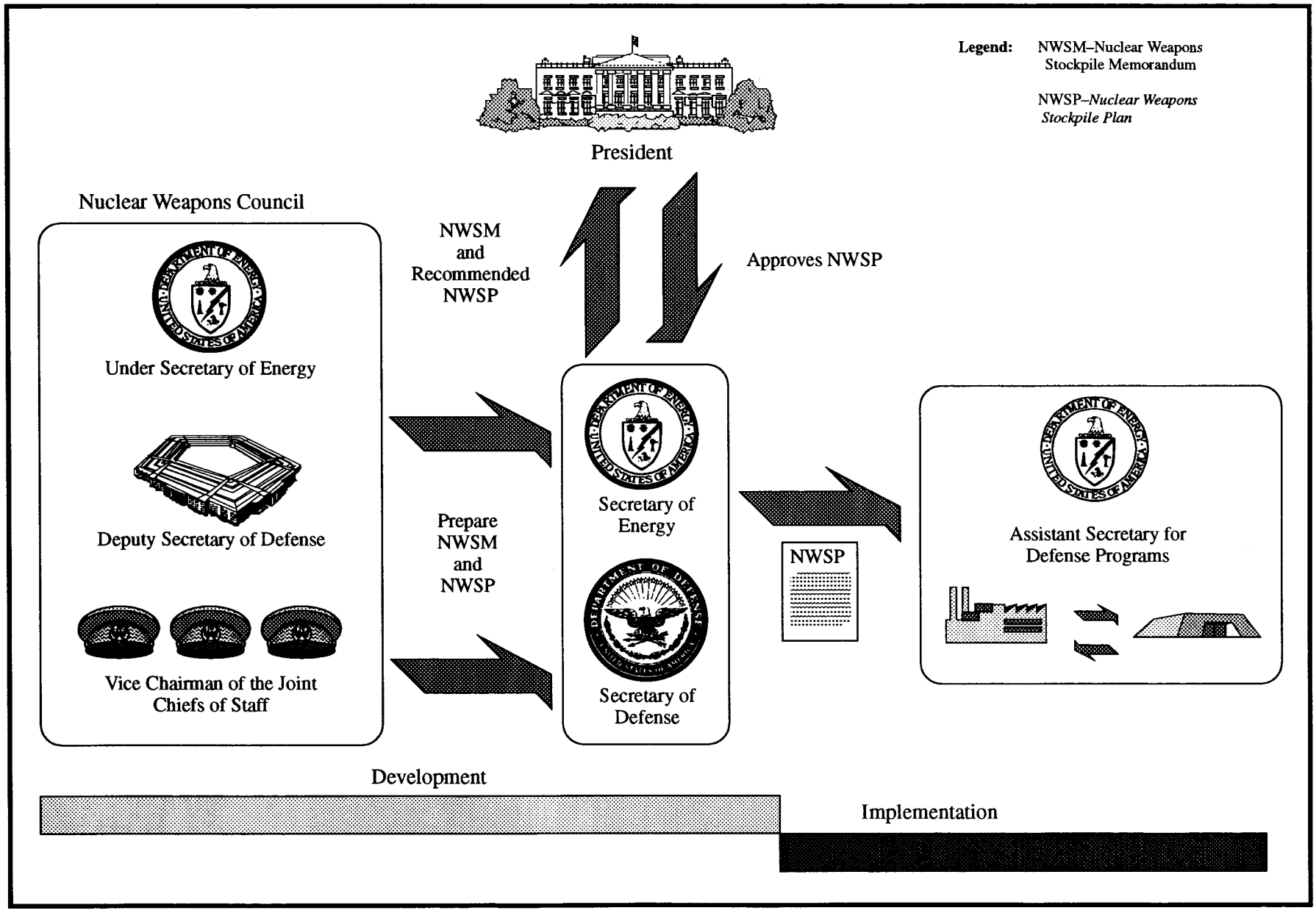


**FIGURE ES–3.**—*Nuclear Weapons Stockpile Plan Process.*

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Nation's nuclear weapons stockpile. However, because tritium decays relatively quickly, recycling can meet the tritium demands for a limited time. Current projections, derived from classified projections of future stockpile scenarios, indicate that recycled tritium will adequately support the Nation's nuclear weapons stockpile until approximately 2011 (figure ES–4). After that time, without a new tritium supply source, it would be necessary to utilize the strategic reserve of tritium in order to maintain the readiness of the nuclear weapons stockpile. The strategic reserve of tritium contains a quantity of tritium maintained for emergencies and contingencies. In such a scenario, once the strategic tritium reserve were depleted, the nuclear deterrent capability would degrade because the weapons in the stockpile would not be capable of functioning as designed. Eventually, the nuclear deterrent would be lost. The proposed tritium supply and recycling facilities would provide the capability to produce tritium safely and reliably in order to meet the Nation's defense requirements well into the 21st century while also complying with environment, safety, and health (ES&H) standards.

DOE has analyzed the activities that must take place in order to bring a new tritium supply source into operation. The analysis indicates that it will take approximately 15 years to research, develop, design, construct, and test a new tritium supply source before new tritium production can begin. Thus, in order to have reasonable confidence that the Nation will be able to maintain an effective nuclear deterrent, prudent management dictates that DOE proceed with the proposed action now. In addition, DOE must meet a statutory deadline of March 1, 1995, to issue a Programmatic Environmental Impact Statement (PEIS) addressing tritium supply alternatives (Public Law 103-160, section 3145).

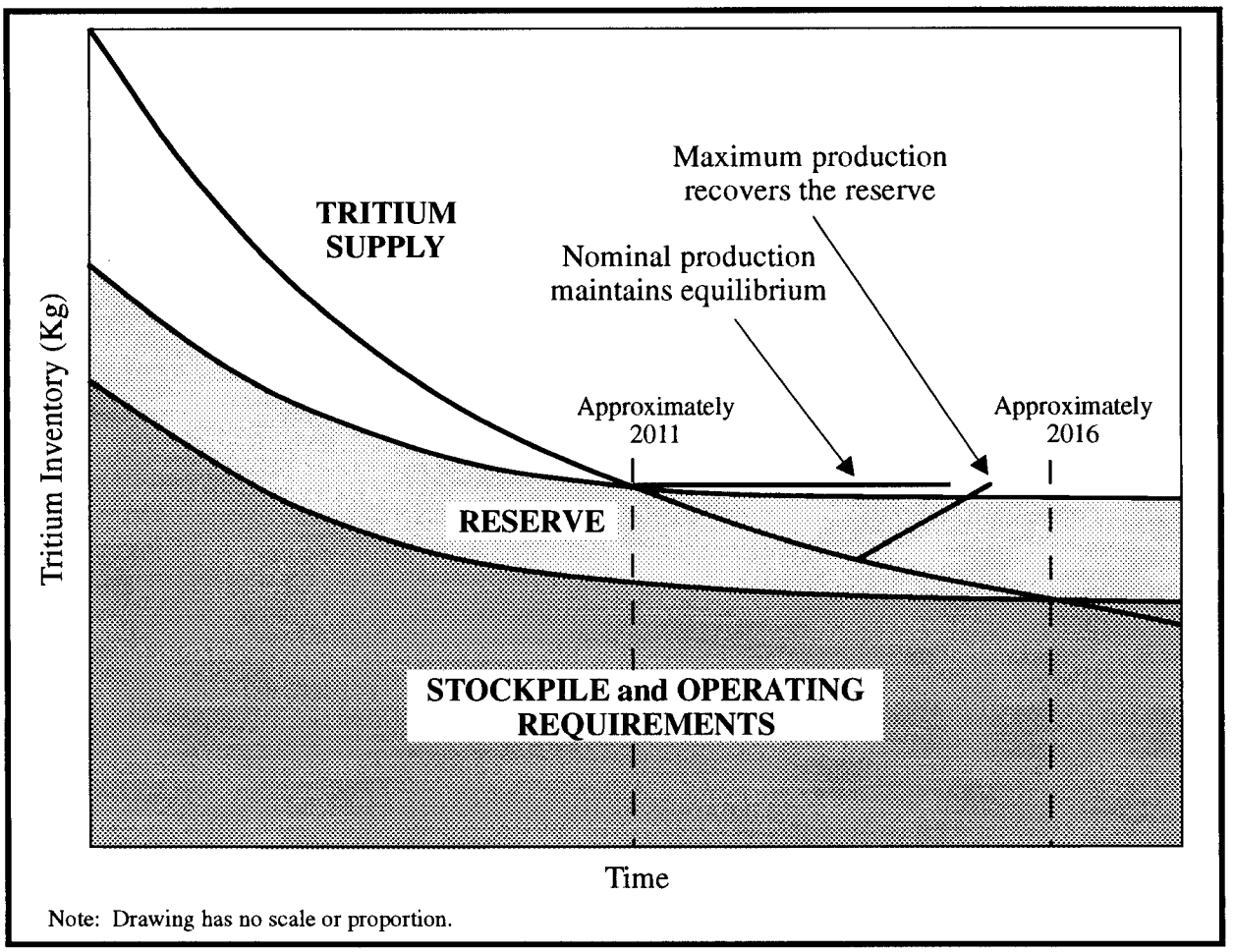


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**FIGURE ES–4.**—***Estimated Tritium Inventory and Reserve Requirements.***

## TRITIUM SUPPLY AND RECYCLING

The tritium supply technologies and site alternatives are described below. For each alternative except those being considered for SRS, a new tritium supply facility could be collocated with a new tritium recycling facility, or the new supply facility could rely on the existing tritium recycling facilities at SRS. For the alternatives at SRS, the new tritium supply facility would utilize existing recycling facilities at SRS, which would be upgraded to support the tritium mission.

**Range of Selected Construction Requirements for Tritium Supply Technologies:**

- **Electrical Energy Demand:**
  40,000 to 120,000 MWh.
- **Land Use:**
  173 to 360 acres.
- **Total Number of Construction Workers:**
  1,350 to 3,500.
- **Water Consumption:**
  41,700,000 to 200,000,000 gal. (over 5 to 9 year period)
- **Steel Consumption**
  45,000 to 68,000 tons

### TECHNOLOGIES

Of the tritium supply technologies considered by DOE for the production of tritium in this PEIS, only the HWR has tritium production operating experience. The MHTGR and light water reactor (upon which the ALWR is based) technologies have been used in electrical power production but lack tritium production experience and development of tritium target technology. The APT technology, which has an operating history in research and development programs, also has no tritium production experience and only recent development of tritium targets.

Since both the MHTGR and the ALWR were developed originally to produce electricity and as such have steam turbines as an integral part of their designs, the PEIS evaluates the environmental effects of both of these technologies with turbines included. The actual sale of steam or generation of electricity by DOE would be covered in the site-specific tiered NEPA documents if either of these technologies were chosen. The general impacts of the transmission lines necessary to carry this generated electricity are discussed. In addition, the general impacts of constructing and operating a dedicated power plant (either coal or natural gas burning) to provide the required power for the APT are also presented. As both the MHTGR and the ALWR technologies could also be used for the ultimate disposition of plutonium, the general impacts of operating these two technologies with plutonium-uranium fuel is presented in the PEIS.

**Heavy Water Reactor.** The HWR would be a low pressure, low temperature reactor whose sole purpose would be to produce tritium. The HWR would use heavy water as the reactor coolant and moderator. Because of the low temperature of the exit coolant, a power conversion system designed to produce electrical power as an option would not be feasible. In addition to the reactor, the HWR complex would consist of several support buildings and other facilities required for the supply and extraction of tritium.

The HWR complex would cover approximately 260 acres and would be surrounded entirely by a security fence. The main reactor would be about 10 stories high and other associated buildings would range from one story to three stories in height. The cooling towers would vary in height, depending on the type of cooling towers utilized. The cooling tower basin, which serves as a holding pond for the cooling towers, would cover approximately 2 acres. In this PEIS, dry sites such as INEL, NTS, and Pantex which lack plentiful surface water sources would use mechanical draft dry cooling towers while wet sites such as ORR and SRS with abundant surface water resources would use natural draft wet cooling towers.

The conceptual design of the HWR complex includes a fuel and target fabrication facility to assemble fuel and target rods that are used in the reactor core; a tritium target processing facility to extract and collect tritium from irradiated targets; an interim spent fuel storage building to store used target and fuel rods; a general services building for administrative

**Range of Selected Operation Requirements for Tritium Supply Technologies:**

- **Electrical Energy Demand:**
  260,000 to 3,740,000 MWh/yr.
- **Land Use:**
  173 to 360 acres.
- **Total Number of Operation Workers:**
  624 to 930.
- **Water Consumption (gal per year):**
  0.03 to 16 billion.
- **Spent Nuclear Fuel Generation:**
  0 to 80 cubic yards per year.

purposes; and a security infrastructure to control access to the complex. Figure ES–5 shows a representative drawing of an HWR complex with mechanical draft cooling towers for illustrative purposes only. The number and arrangement of buildings and support areas are descriptive only and can change significantly as design progresses. The fuel and target fabrication facility would be a steel or concrete structure designed to control the spread of contamination within the building and prevent the uncontrolled release of radioactive material. The target processing facility would consist of two attached structures: a process building and a support building. The process building would include the laboratory and other activities associated with handling tritium. The support building contains offices, maintenance areas, and nonradioactive ventilation systems.

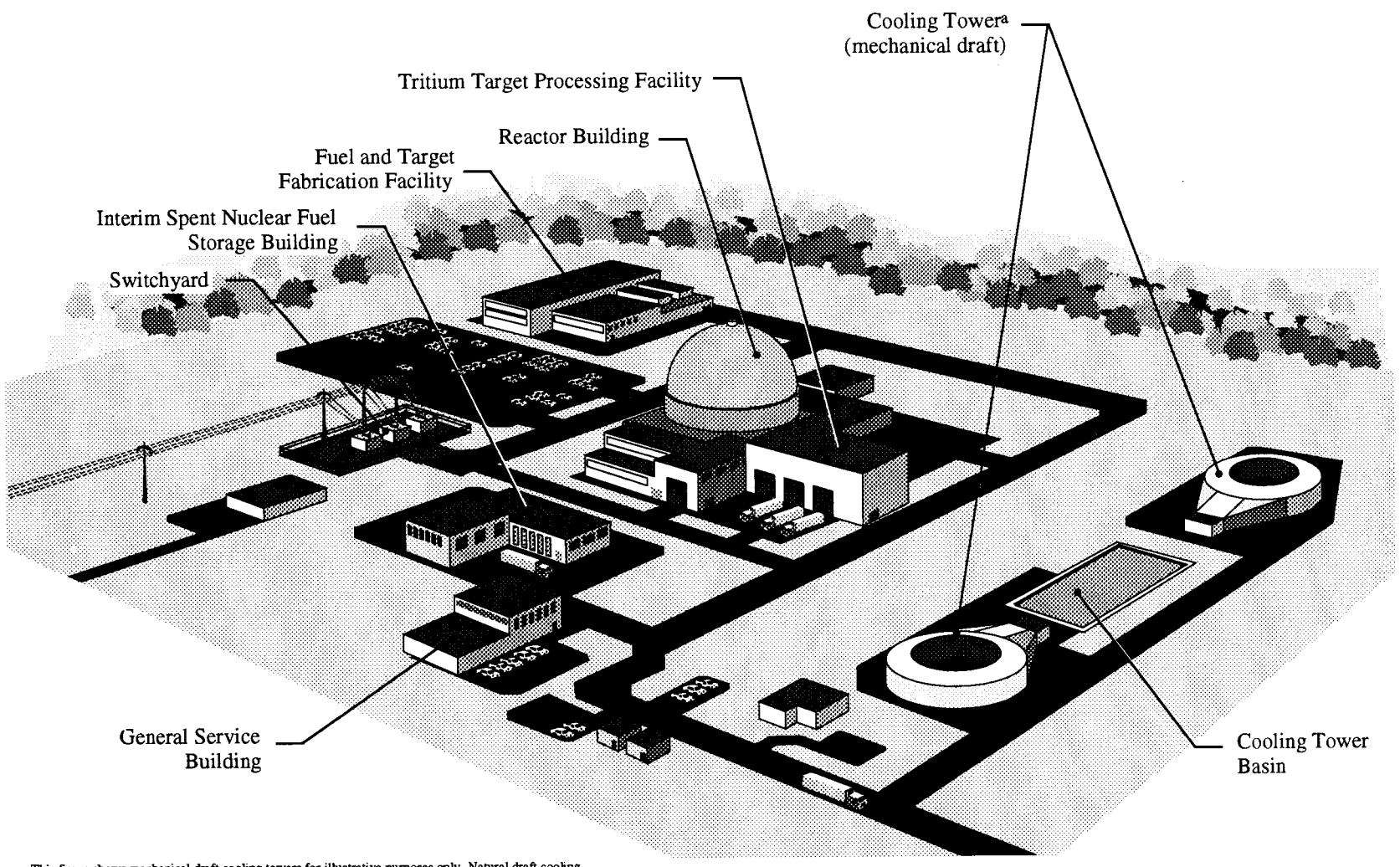
The design of the HWR would incorporate numerous safety features including: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety related loads in the event of temporary failure of the offsite power supply; a reactor containment building to limit any operational or accidental release of radioactivity; an emergency core cooling system to makeup coolant for heat removal in the event of a loss of coolant or a loss of pumping; an emergency shutdown system with safety rods independent of the reactor control rods; a neutron poison system to inject neutron-absorbing material into the moderator tank; and a backup system to remove heat from the reactor if the primary coolant fails to circulate.

Construction of the HWR would take somewhat less than 8 years and require approximately 2,320 workers during the peak construction period. Once constructed, approximately 1 to 2 years would be needed for systems checkout of the reactor prior to actual tritium production. Operation of the HWR would require approximately 930 workers.

**Modular High Temperature Gas-Cooled Reactor.** The MHTGR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium. The MHTGR would use helium gas as a core coolant and graphite as a moderator. Because of the high temperature of the exit coolant, a power conversion facility designed to produce electricity is an integral part of the design and is included in the analysis. In addition to the reactor building and the power conversion building, the MHTGR complex would consist of several buildings and other facilities required for the supply and extraction of tritium.

The MHTGR complex would cover approximately 360 acres and would be surrounded entirely by a security fence. The MHTGR would consist of three 350 MWt reactor vessels housed in adjacent, below-ground, reinforced-concrete silos. The silos would extend approximately 160 feet below-grade and each reactor vessel would be about 22 feet in diameter and 75 feet high. Each reactor vessel would contain a reactor core, reflectors, and associated supports. A shutdown cooling heat exchanger and a shutdown cooling circulator would be located at the bottom of the vessels. Support buildings and other associated facilities within the MHTGR complex would range in height from one to three stories. Two cooling towers would be needed and their height would vary, depending on the type of cooling towers that are utilized. In this PEIS dry sites (INEL, NTS, and Pantex) would use mechanical draft dry cooling towers and wet sites (ORR and SRS) would use natural draft wet cooling towers.

The design of the MHTGR complex would include a fuel and target fabrication facility, a tritium target processing building, helium storage buildings, waste




[a] This figure shows mechanical draft cooling towers for illustrative purposes only. Natural draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: FDI 1994d.

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**FIGURE ES–5.—*Heavy Water Reactor Facility (Typical).***

treatment facilities, spent fuel storage facility, a general services building, a security infrastructure, and a power conversion facility consisting of three turbine-generators and associated electrical control equipment. Figure ES–6 shows a representative drawing of a MHTGR complex with mechanical draft cooling towers shown for illustrative purposes only. The number and arrangement of buildings and support areas are descriptive only and can change significantly as design progresses.

The design of the MHTGR would incorporate numerous safety features that include: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety related loads in the event of temporary failure of the offsite power supply; a below-grade design, which serves as a barrier to external hazards (aircraft, turbine blades, and tornado-generated debris), reduces seismic-induced stress on the reactors, and provides radiological shielding; a below-grade containment structure made of reinforced concrete; an emergency core cooling system; and an emergency shutdown system with safety rods independent of the reactor control rods.

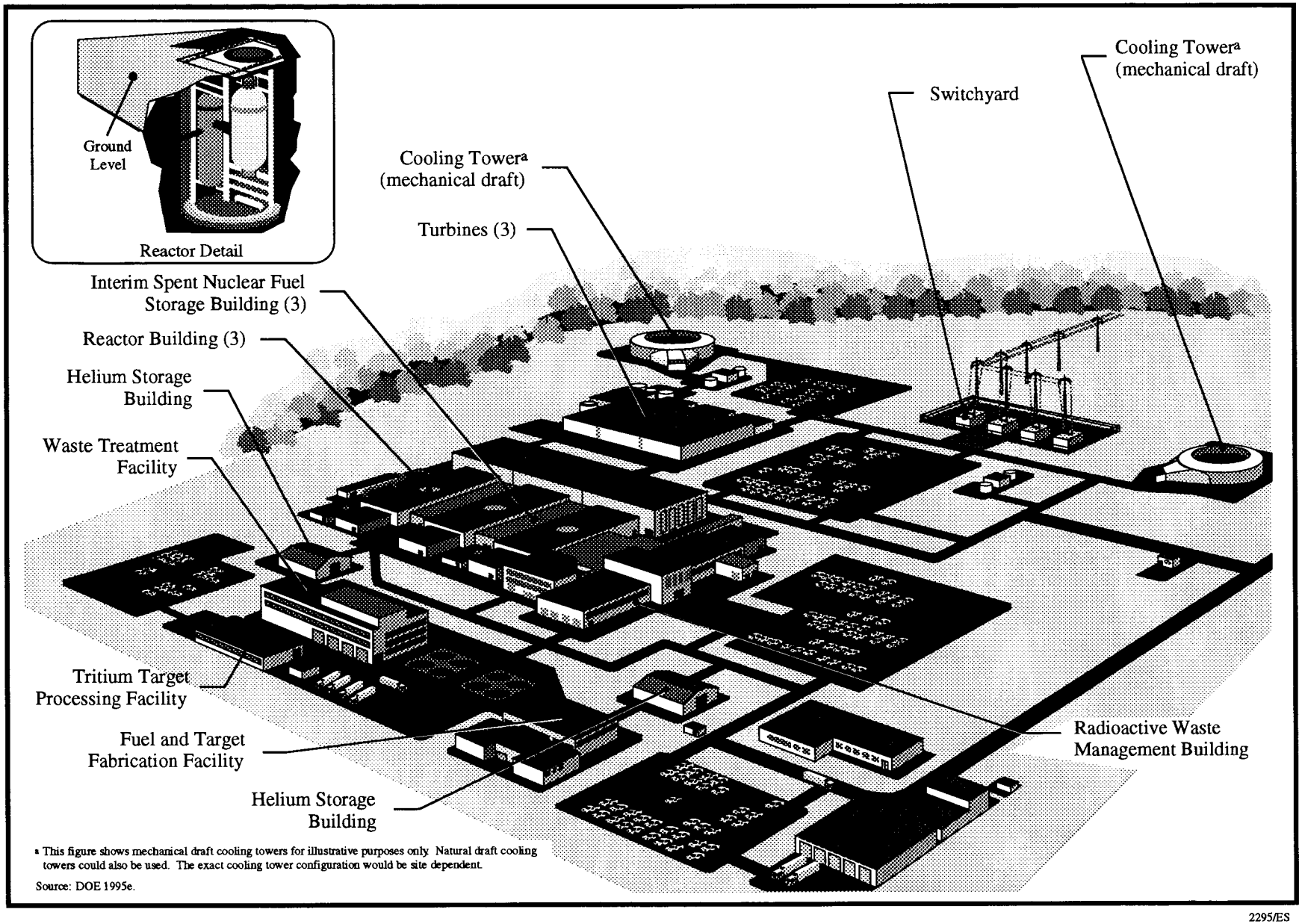
Construction of the MHTGR would take about 9 years and require approximately 2,210 workers during the peak construction period. One to two years would be needed after construction for system check-out of the reactor prior to actual tritium production. Operation of the MHTGR would require approximately 910 workers.

A modular gas-cooled reactor like the MHTGR would also be capable of performing the "triple play" missions of producing tritium, burning plutonium, and generating electricity. To burn plutonium in a gas-cooled reactor, a plutonium pit disassembly/conversion/plutonium-oxide fuel fabrication facility would be needed. Additionally, because tritium production decreases significantly in a plutonium-fueled gas-cooled reactor, twice as many reactor modules would be necessary in order to produce the steady-state tritium requirements. This doubling of reactor modules would be the major contributor to potential environmental impacts for this scenario. The PEIS contains an assessment of these potential environmental impacts.

**Advanced Light Water Reactor**. The ALWR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium. There are two options for the proposed ALWR technology: a Large ALWR (1300 MWe) and a Small ALWR (600 MWe). The large and small options would be chosen from the following four candidates: a large or small pressurized water reactor; or a large or small boiling water reactor. All ALWR options would use light (regular) water as the reactor coolant and moderator. Like the MHTGR, a power conversion facility (steam turbine) is an integral part of the design for the ALWR because of the high temperature of the exit coolant and is included in the analysis. In addition to the reactor building, the ALWR complex would consist of several support buildings and other facilities for the supply and extraction of tritium.

The ALWR would cover approximately 350 acres and the whole complex would be surrounded by a security fence. The main reactor building would be approximately 10 stories high. The other associated buildings would range from one to three stories in height. The differences between the large and small options are primarily in the power output of the reactors. Both of the small reactors are rated at 600 MWe, while the large options are rated at 1,300 MWe. The physical sizes of the large and small options for each of the technologies are generally the same.

In addition to the reactor, the ALWR complex would include an interim spent fuel storage building, a waste treatment facility, a tritium target processing facility, warehouses, and a power conversion facility. Unlike the other technologies, the ALWR would not have a fuel fabrication facility since fuel rods would be obtained from offsite sources. Figure ES–7 shows a representative drawing of an ALWR complex with a natural draft cooling tower shown for illustrative purposes only. The number and arrangements of buildings and support areas are descriptive only and can change significantly as design progresses. The tritium target processing facility would consist of the following two attached structures: a processing building and a support building. The process building would include the tritium extraction processes, laboratory, and other activities associated with handling tritium. The support building would contain offices, maintenance areas, and nonradioactive ventilation systems. The type of cooling tower

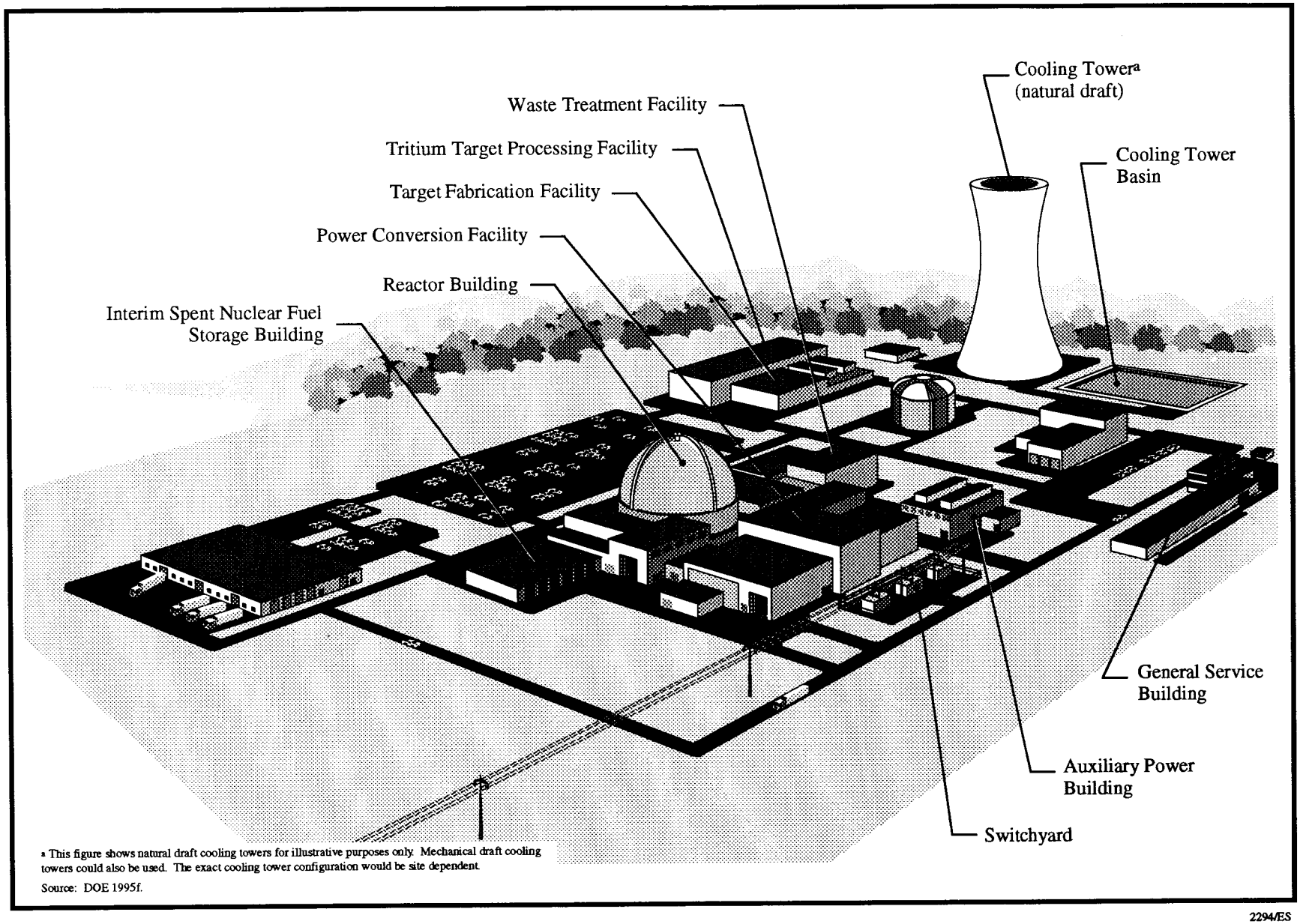



[a] This figure shows mechanical draft cooling towers for illustrative purposes only. Natural draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995e.

2295/ES

**FIGURE ES–6.—*Modular High Temperature Gas-Cooled Reactor Facility (Typical).***




[a] This figure shows natural draft cooling towers for illustrative purposes only. Mechanical draft cooling towers could also be used. The exact cooling tower configuration would be site dependent.

Source: DOE 1995f.

2294/ES

**FIGURE ES–7.—*Advanced Light Water Reactor Facility (Typical).***

used depends upon where the ALWR were located. In this PEIS dry sites (INEL, NTS and Pantex) would use mechanical draft dry cooling towers and wet sites (ORR and SRS) would use natural draft wet cooling towers.

The design of the ALWR would incorporate numerous safety features such as: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety-related loads in the event of temporary failure of the offsite power supply; a reactor containment building to limit any release of radioactivity; an emergency core cooling system to makeup coolant in the event of a loss of coolant or a loss of pumping; an emergency shutdown system; and a neutron poison system to inject neutron-absorbing material into the reactor vessel.

Construction of the ALWR would take about 6 years and require approximately 3,500 workers for the Large ALWR and 2,200 workers for the Small ALWR during the peak construction period. Once constructed, 1 to 2 years would be needed to check out the reactor prior to actual tritium production. Operation of the Large and Small ALWR would require approximately 830 and 500 workers, respectively.

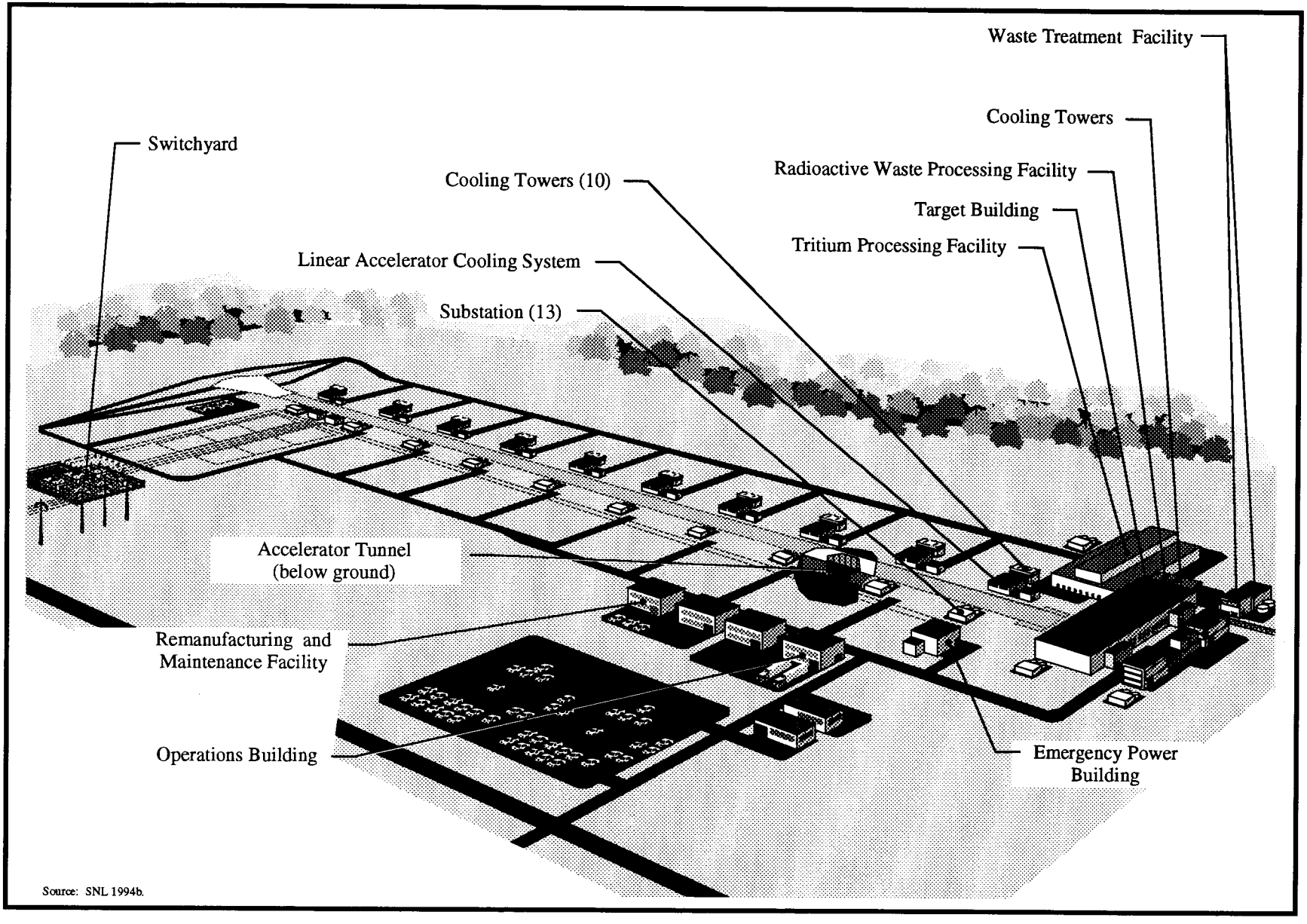
An ALWR would also be capable of performing the "triple play" missions of producing tritium, burning plutonium, and generating electricity. The multipurpose ALWR would operate essentially the same as a uranium-fueled tritium production ALWR. Therefore, the environmental impacts from operation of a multipurpose ALWR would be expected to be unchanged from the tritium production ALWR. To burn plutonium in an ALWR, a plutonium pit disassembly/conversion/mixed-oxide fuel fabrication facility would be needed to provide the mixed-oxide fuel rods for the ALWR, and would be the major contributor to potential environmental impacts for this scenario. The PEIS contains an assessment of these potential environmental impacts.

**Accelerator Production of Tritium.** The APT would be a linear accelerator whose primary purpose would be to produce tritium. The APT accelerates a proton beam in a long tunnel to one of two target/blanket assemblies located in separate target stations. There are two target/blanket concepts being considered in the conceptual design of the full size APT: the helium-3 target and the spallation-induced lithium conversion target.

The APT complex would cover approximately 173 acres and would be surrounded entirely by a security fence. The accelerator, 3,940 feet in length, would be housed in a concrete tunnel buried 40 to 50 feet underground for radiation shielding. The design of the APT radio frequency power system and its distribution network is similar to that of existing accelerators. The tunnel would be sealed and evacuated during operation but would vent to the atmosphere during shutdown period. The full size facility would consist of 10 cooling towers and 13 substations located above ground along the full length of the underground accelerator. The APT facility would require a peak electrical load of approximately 550 MWe to produce the 3/8 goal tritium quantity, and 355 MWe to produce the steady-state tritium requirement. Additionally, there would be two cooling towers for the target/blanket beam stop, located next to the target building. The cooling towers and the substations would be approximately one to two stories in height.

The preconceptual design of the APT complex includes: a target building that would house either the helium-3 or the spallation-induced lithium conversion target chambers located in a subterranean structure at the same level as the accelerator; a tritium processing facility to extract tritium from the targets; a klystron remanufacturing and maintenance facility; waste treatment buildings to treat all generated wastes; and various administration, operation, and maintenance facilities. Figure ES–8 shows a representative drawing of an APT complex. The number and arrangement of buildings and support areas are illustrative only and can change significantly as design progresses.

The design of the APT would incorporate numerous safety features to include: an emergency power facility to house diesel generators or gas turbines for short-term emergency power to support safety-related loads in the event of temporary failure of the offsite power supply; multiple sensors and diagnostics which would determine if the accelerator beam is out of acceptable limits in terms of position, energy, size, etc.; redundant cooling systems for all heat-removal systems; and an automatic beam shutoff in




Source: SNL 1994b.

2296/ES

**FIGURE ES–8.—*Accelerator Production of Tritium Facility Site Layout (Typical).***

the event of a loss of cooling, a misaligned beam, or abnormal radiation levels.

Construction of the APT would take about 5 years and require approximately 1,350 workers during the peak construction period. Additional construction area for equipment and materials would not be required since there would be sufficient unencumbered space within the APT boundaries. Once constructed, 1 to 2 years would be needed to check out the accelerator prior to actual tritium production. Operation of the APT would require approximately 624 workers.

If desired, a phased construction of the APT could also occur. Under this scenario, initial construction of the APT would result in a facility that could produce the steady-state requirement of tritium (approximately 50 percent of baseline case). Expansion of the facility could be possible at a later date in order to increase tritium production to the baseline requirements if necessary. The helium-3 target is the primary target in the Phased APT option.

### TRITIUM RECYCLING

The primary mission of the tritium recycling facility is to process and recycle tritium for use in nuclear weapons. This mission includes the steps necessary to empty reservoirs (small pressure vessels containing tritium installed in nuclear weapons), recover the tritium, provide new gas mixtures according to specifications, and reclaim usable reservoirs. Additionally, the tritium recycling facility would perform a full range of analytical, physical, and environmental tests to ensure that the quality and integrity of all reservoirs are maintained throughout their operational life. It would also provide for appropriate waste management, including storage, treatment, and disposal of tritiated wastes.

The tritium recycling facility would receive tritium in reservoirs returned from DOD and other activities, or as new tritium from the extraction facility that is associated with the tritium supply facility. The reservoirs would be unpacked from their shipping containers in the auxiliary building and taken to the tritium processing building for temporary storage. They would then be emptied and the contained gases would be processed to separate the hydrogen isotopes from other gases, primarily helium-3 (a stable isotope resulting from the radioactive decay of tritium). Prior to being placed into reservoirs, the tritium would undergo a purification process. The empty reservoir bottles would be sent to the tritium auxiliary building to be reclaimed. If reclamation is not possible, the bottles would be disposed of as LLW. Otherwise, they would be refurbished and sent to the tritium processing building to be filled.

Reservoirs that have been filled with tritium and sealed would be transferred to the auxiliary building for finishing, where they would be decontaminated, leak tested, inspected, marked, measured for tritium content, and, if required, combined with various parts necessary for final assembly. The reservoirs would then be placed in storage until needed for limited life component exchange, or sent to the assembly and disassembly facility for use in new weapons.

Some reservoirs would be placed in the weapon surveillance program. The tritium recycling facility would include testing capability for production, surveillance, and research and development reservoirs. In general, tests on reservoirs filled with tritium would be performed in the tritium processing building, while tests on other bottles or parts of bottles would be performed in the auxiliary building.

Tritium recycling could be collocated with tritium supply, or be done in existing facilities at SRS. At SRS, an upgrade of the existing recycling facilities would be implemented rather than construction of a new facility. Discussed below are the options for new or upgraded recycling facilities.

**New Recycling Facilities.** If the tritium supply and recycling facilities are located at any site other than SRS, new recycling facilities would have to be constructed (figure ES–9). The tritium recycling facility would be housed in two major buildings and in several support facilities. The first building, the tritium processing building, would be a hardened facility designed with systems to contain tritium releases should they occur. The second building, the auxiliary building, would house non-tritium and extremely small amounts of working tritium. These buildings would be located within a 202-acre plant area.

**Upgrade of Recycling Facilities at the Savannah River Site.** If the tritium supply facilities are located

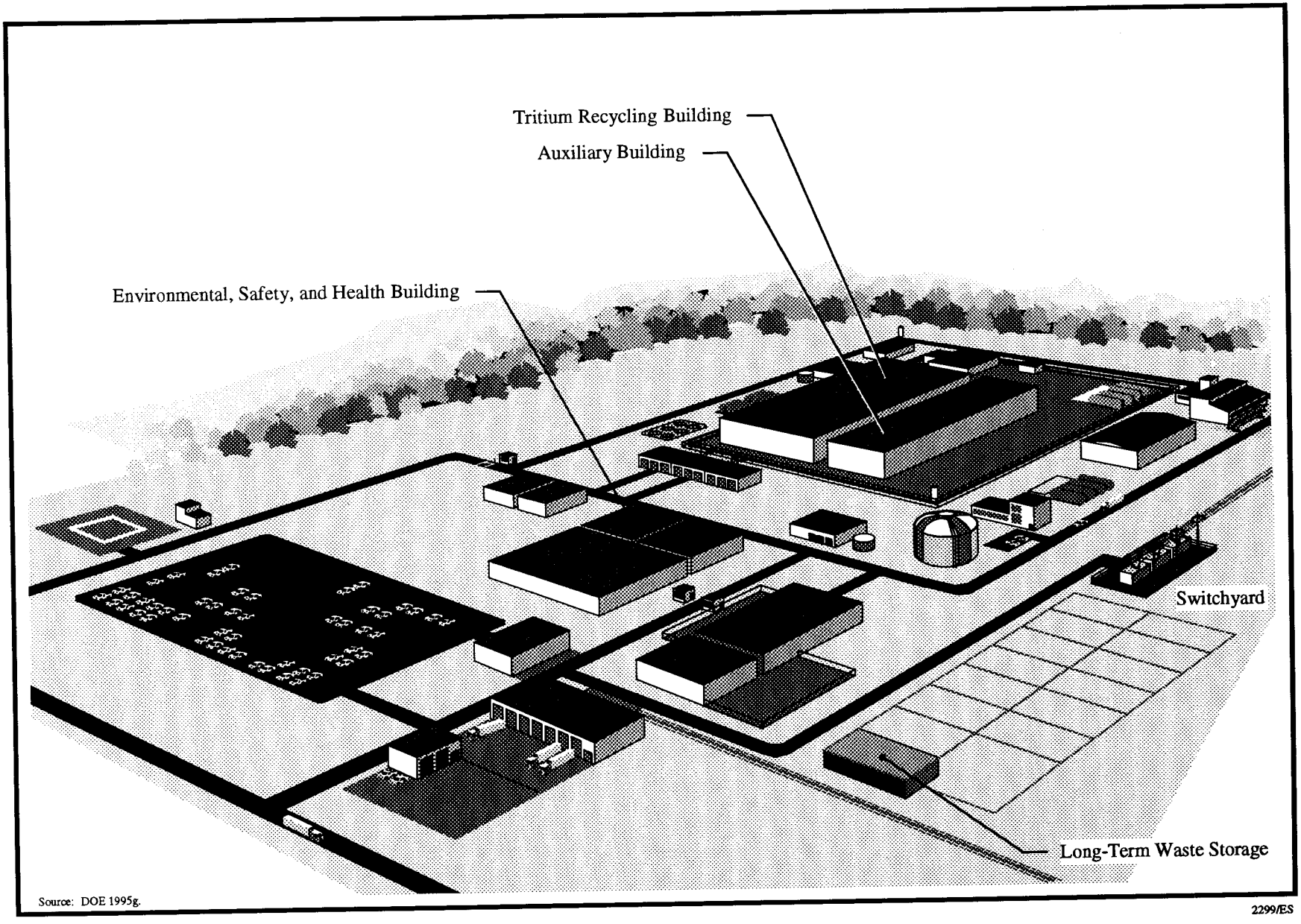



**FIGURE ES–9.—*New Tritium Recycling Facility (Typical).***

at SRS or at one of the other sites without a collocated recycling facility, the existing tritium recycling facilities would be upgraded. The upgrade, presented here, called the unconsolidated upgrade, would result in no buildings closed and no consolidation of tritium handling activities. Buildings 232-H, 232-1H, 234-H, 238-H, and 249-H (figure ES–10), would be upgraded to meet DOE Natural Phenomenon Hazards Requirements. These upgrades would involve adding of wall and cross bracings to existing beams, strengthening some exterior walls, and reinforcing existing building frames. Additionally, Building 232-H would require an anchor for the service area roof slab as well as an upgrade to the Radiation Control and Monitoring System. Building 234-H would require upgrades to its reservoir storage encased safes which are used to protect filled reservoirs during high winds and earthquakes. No additional acreage would be required for these upgrades, and no upgrade modifications would be required for buildings 233-H (Replacement Tritium Facility), 235-H, 236-H, or 720-H.

As a potential mitigation, a consolidation of tritium activities into fewer buildings to minimize tritium emissions and waste is also possible. In this upgrade, called the consolidated upgrade, Building 232-H would be closed and its functions transferred to buildings 233-H and 234-H. As discussed above, upgrades would then be made to buildings 232-1H, 234-H, 238-H, and 249-H. Additionally, Building 233-H would require modifications in order to accept activities transferred from Building 232-H.

## SITES

### IDAHO NATIONAL ENGINEERING LABORATORY

In 1949, INEL was established in the southeastern Idaho desert 50 miles west of Idaho Falls. Situated on approximately 570,000 acres in four counties, the site is used to test, build, and operate nuclear facilities. INEL is one of DOE's primary centers for research and development activities on reactor performance, materials testing, environmental monitoring, waste processing, and breeder reactor development and serves as a naval reactor training site. The collection of reactors at INEL is the world's largest, varying from research and testing to power and ship propulsion reactors. Over the years, 52 research and test reactors at INEL have been used to test fuel and target design, reactor systems, and overall safety. Currently, there are four reactors in use, three of which are in continuous operation.

In addition to nuclear reactor research, other INEL facilities support reactor operations; processing and storage of high-level waste (HLW) and low-level waste (LLW); and storage of LLW and transuranic (TRU) waste generated by defense program activities. Until 1992, spent reactor fuels were reprocessed at the Idaho Chemical Processing Plant but this was terminated by DOE. Therefore, INEL has no current defense program missions.

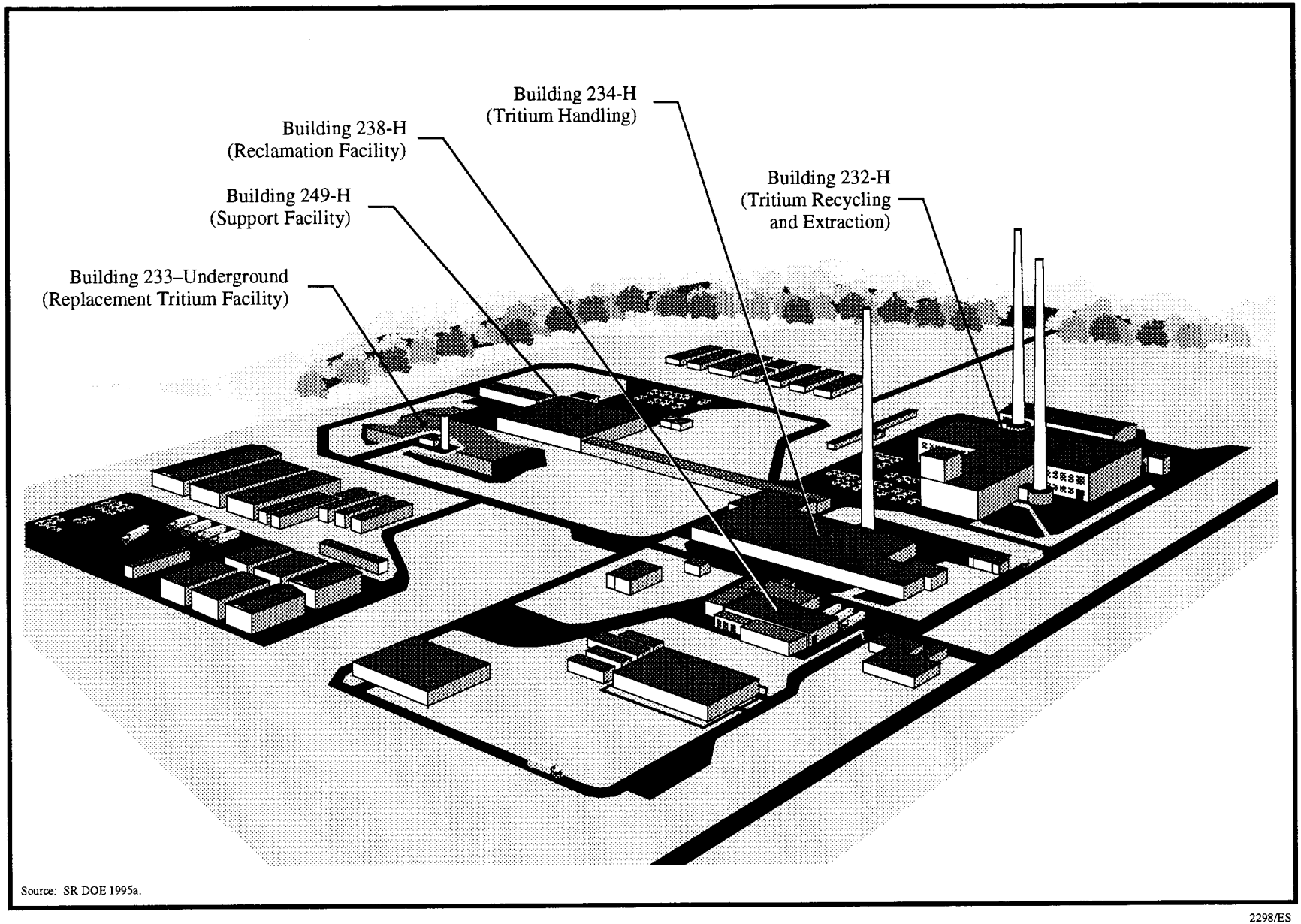
### NEVADA TEST SITE

In 1950, NTS was established in southern Nevada 65 miles northwest of Las Vegas, on approximately 864,000 acres of land. NTS is operated by several management and operating contractors under the direction of the Nevada Operations Office. The site is a remote, secure facility for conducting underground testing of nuclear weapons and evaluating the effects of nuclear weapons on military communications, electronics, satellites, sensors, and other materials. Approximately one-third of the land is used for nuclear weapons testing, one-third is reserved for future missions, and one-third is used for research and development and other facility requirements. In October 1992, the underground nuclear testing was halted, yet the site maintains the capability to resume testing if authorized by the President.

Facilities at NTS include nuclear device assembly, diagnostic canister assembly, hazardous liquid spill, and the Radioactive Waste Management Site. In addition, DOE is evaluating Yucca Mountain, an area on the border of the site, as a potential repository for spent nuclear fuel and high-level radioactive waste.

### OAK RIDGE RESERVATION

ORR was established in 1942 as part of the World War II Manhattan Project. The site, located 20 miles west of Knoxville on approximately 35,000 acres, includes three major facilities: Oak Ridge National Laboratory; Y-12 Plant (Y-12); and the K-25 site (the former Oak Ridge Gaseous Diffusion Plant). Oak Ridge National Laboratory missions include basic and applied scientific research and technology development. Y-12 engages in national security activities




Source: SR DOE 1995a.

2298/ES

**FIGURE ES–10.**—***Tritium Recycling Facilities Upgrades at Savannah River Site (Generalized).***

and manufacturing outreach to U.S. industry. The K-25 site serves as an operations center for environmental restoration and waste management programs.

Y-12 is the primary location for defense program missions. Activities at Y-12 include the dismantling of nuclear weapons components returned from the Nation's stockpile, maintaining nuclear production capability (primarily uranium and lithium) and stockpile support, storing special nuclear materials, and providing special manufacturing support to DOE programs. Operational space at Y-12 is being downsized in response to the reduced workloads.

### PANTEX PLANT

Pantex is located 17 miles northeast of Amarillo, TX, on approximately 16,000 acres. The site served as a conventional bomb plant during World War II. After the war, the site was sold to Texas Technological College (Texas Tech) but was repurchased by the Army in 1951 at the request of the Atomic Energy Commission. Pantex served as a nuclear weapons production facility and over the years absorbed the weapons modification functions of the Clarksville, TN (1965) and Medina, TX (1966) plants. In 1975, Pantex absorbed the functions of the decommissioned Burlington Plant in Iowa.

Today, Pantex functions include the fabrication of chemical explosives; nuclear weapons assembly, disassembly, testing, quality assurance, repair, and disposal of nonnuclear components; and development work in support of design laboratories. Due to recent reductions in the Nation's stockpile, Pantex has developed the interim capability for sealed pit storage of nuclear materials. Pantex is the only DOE facility that can execute the final assembly of a nuclear weapon for the DOD stockpile. At present, weapons disassembly and component storage dominate activity at the plant.

### SAVANNAH RIVER SITE

In 1950, SRS was established 12 miles south of Aiken, SC, on approximately 192,000 acres. The major nuclear facilities at SRS have included fuel and target fabrication facilities; nuclear material production reactors; chemical separation plants used for recovery of plutonium and plutonium isotopes; a uranium fuel reprocessing area; and the Savannah River Technology Center, which provides process support.

SRS is the Nation's primary facility for tritium recycling operations, which provide tritium for weapons in the nuclear stockpile. Recycled tritium is delivered to Pantex for weapons assembly and directly to DOD to replace expired tritium reserves. In the past, SRS produced tritium but only tritium recycling operations continue at the Replacement Tritium Facility. Other activities at SRS include interim storage of plutonium, waste management, and environmental monitoring and restoration.

## ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

By law, DOE is required to support the Nuclear Weapons Stockpile Plan. To do this, DOE must maintain a nuclear weapons production, maintenance, and surveillance capacity consistent with the President's Stockpile Plan. For the proposed action, the following alternatives were considered but eliminated from detailed study for the reasons stated.

### PURCHASE OF TRITIUM FROM FOREIGN SOURCES

DOE has considered the purchase of tritium from other sources, including foreign nations. Conceptually, the purchase of tritium from foreign governments could provide a fraction of the tritium requirement. However, while there is no national policy against purchase of defense materials from foreign sources, DOE has determined that the uncertainties associated with obtaining tritium from foreign sources render this alternative unreasonable for an assured long-term supply.

### REDESIGN OF WEAPONS TO REQUIRE LESS OR NO TRITIUM

The nuclear warheads in the enduring stockpile were designed and built in an era when the tritium supply was assured, when underground nuclear testing was being conducted, and when military needs required that the warheads be optimized in terms of weight and volume. Replacing these warheads with new ones that would use little or no tritium for the sole reason of reducing overall tritium demand would be infeasible and unreasonable. Without underground nuclear testing to verify their safety and reliability,

new warhead designs cannot deviate very far from current designs that require the use of tritium. Even with underground testing to facilitate new designs and a fully operational production complex, it would still take many years to build enough warheads to replace the enduring stockpile. Therefore, replacing the enduring stockpile of warheads with new designs would most likely take longer and could cost more than constructing and operating a new tritium supply facility. Because neither the President nor the Congress has approved that the government embark on a costly and expansive design, testing, and construction program solely to eliminate tritium requirements, weapons redesign to use less or no tritium is not a reasonable short- or long-term alternative.

### Use of Existing Department of Energy Reactors or Accelerators

DOE (and its predecessor agencies) has designed, constructed, and operated a number of nuclear reactors over the past 50 years. The majority of these reactors were designed to assist in the development of nuclear research and safety standards development. DOE has also constructed nuclear reactors to produce the materials required to support the production and maintenance of nuclear weapons and has constructed nuclear reactors in support of the Naval Propulsion Program.

Among the first experimental reactors were the Water Boiler at Los Alamos National Laboratory and CP-3 at Argonne National Laboratory, which were completed in 1944. Since then, numerous experimental and research reactors were constructed for a variety of purposes, including material tests, new reactor concepts, and safety experiments. Only four DOE research reactors are currently in operation: the High Flux Isotope Reactor at ORR; the High Flux Beam Reactor at Brookhaven National Laboratory; and the Experimental Breeder Reactor-II and the Advanced Test Reactor at the INEL. In addition, there are some low power/critical facilities supporting medical research (at Brookhaven) and supporting reactor core configuration research (at Argonne National Laboratory-West at INEL). None of these facilities is large enough to produce the amount of tritium required to support the projected stockpile requirements. All are currently committed to existing programs, and were constructed in the early 1960s, rendering their design life reliability unsuitable for the timeframe required for a new, assured, long-term tritium supply facility.

Of the existing DOE reactors that are currently not being operated, only one has the potential for producing any significant quantities of tritium: the Fast Flux Test Facility at the Hanford Site. This facility was designed and constructed to perform materials research for the national liquid-metal breeder reactor program. This small (440-megawatt thermal (MWt)) experimental reactor, based on liquid-metal reactor technology, could, after substantial core and cooling system modifications, as well as target technology development, have the potential to supply a significant percentage of the steady state tritium requirement. The Fast Flux Test Facility, however, was designed in the late 1970s and began operation in 1980. In 2010, it will already be 10 years past its design 20-year lifetime. Relying on the ability to modify and operate the Fast Flux Test Facility well into the middle of the next century is not a reasonable alternative.

DOE also constructed and operated more than a dozen nuclear reactors for production of nuclear materials at SRS and the Hanford Site, starting with the early part of the Manhattan Project during World War II. None of these reactors is currently operational. Of those reactors specifically designed to produce nuclear materials for the nuclear weapons program, the K-Reactor at SRS is the only remaining reactor which could be capable of returning to operation. It is currently in a "cold stand-by state" and has not been operated since 1988. The reactor was shut down for major environmental, safety, and health upgrades, to comply with today's stringent standards. DOE discontinued the K-Reactor Restart Program when the reduced need for tritium to support a smaller stockpile delayed the need for tritium. In this context—reliance upon the ability to upgrade and operate well into the middle of the next century—a first generation reactor designed in the 1940s is not a reasonable alternative for new, long-term, assured tritium supply.

DOE has been a world leader in the design and construction of particle accelerators and currently operates six national facilities. Of the existing research accelerators, none is capable of producing significant quantities of tritium. The existing DOE research accelerators are all of the pulsed design and

are only capable of producing low power accelerator beams in the 800 kilowatt (kW) range. A production accelerator facility, utilizing continuous wave operation, would be required to deliver a high power proton beam of 100 megawatts (MW) for tritium production. None of the existing research accelerators could be reasonably upgraded to meet the long-term, assured tritium requirements.

### USE OF COMMERCIAL REACTORS

Tritium could be produced directly in existing light water reactors by irradiating target rods made from lithium. However, the production of tritium for defense purposes in nuclear reactors that generate electricity for commercial sale would be contrary to the long-standing policy of the United States that civilian nuclear facilities should not be utilized for military purposes. Such use of commercial reactors would make the United States non-proliferation efforts much more difficult because other countries could demand equal footing. For this reason, DOE does not consider the use of commercial reactors to be a reasonable alternative for a long-term assured supply of tritium to be evaluated in the PEIS. However, as previously discussed, the PEIS evaluates the impacts associated with the use of an existing light water reactor to produce tritium, whether an existing reactor were used on a contingency basis to produce tritium in a national emergency, or the Department chose at some future date to purchase an existing reactor and convert it to defense purposes as a long-term source of tritium. Therefore, a discussion of the generic environmental impacts of the production of tritium in a commercial reactor is presented in the PEIS.

### ALTERNATIVE SITES

The process of determining these reasonable tritium supply alternative sites has been evolutionary, starting with the engineering studies and criteria developed by the New Production Reactor program, then utilizing additional criteria and considerations from the Reconfiguration Program, information related to changing missions at DOE sites, and input from public scoping.

During the preparation of this draft PEIS, the Department has continued to assess other alternative sites. In fact, once the APT was added as a potential tritium supply technology, an assessment was conducted to determine if the Los Alamos National Laboratory, which operates a linear accelerator and is the home of significant accelerator expertise, would be a reasonable site for a tritium producing accelerator.

The APT conceptual designs for tritium supply have established that evaporative cooling towers would be used to dissipate the heat generated in the tritium target assemblies and in the accelerator facility. These APT cooling water requirements are significantly greater than the current regulated allotment of water for Los Alamos National Laboratory and increasing the allotment to support the APT water requirement would be impractical and infeasible, and in any event beyond DOE's control.

It may be possible that an APT could use non-evaporative cooling towers, which would greatly reduce the water requirements. However, there is sufficient technical uncertainty regarding the feasibility and practicality of using non-evaporative cooling towers for a continuous wave APT to render this option unacceptable as a source for the Nation's only supply of tritium. The other five sites being analyzed in this PEIS could reasonably support the water requirements of the APT using evaporative cooling towers and, thus, would not incur the technical uncertainty and risk of Los Alamos National Laboratory. Thus, DOE has concluded that Los Alamos National Laboratory is not a reasonable site for an accelerator to produce tritium. (LA DOE 1994a:1)

## ENVIRONMENTAL RESOURCE IMPACT METHODS

The following is a brief description of the impact assessment approach used in the PEIS for addressing potential impacts of the tritium supply and recycling action.

### LAND RESOURCES

**Land Use.** Land use impacts are assessed based on the extent and type of land that would be affected, and potential direct impacts resulting from the conversion or the incompatibility of land use changes with special status and protected lands.

**Visual Resources.** Visual impacts are assessed based on whether changes in existing facilities or

construction of new facilities would appear uncharacteristic in each site's visual setting and, if so, how noticeable the changes would be.

### Site Infrastructure

Changes to site infrastructure are assessed by overlying the support requirements of the respective tritium supply technologies and recycling facilities upon the projected site infrastructure capacities. These assessments focus upon power requirements, road networks, rail interfaces, and fuel requirements. The basis for the PEIS assessment is the supply and demand projections of the U.S. electric utilities published annually by the North American Electric Reliability Council.

### Air Quality and Acoustics

The assessment of potential impacts to air quality is based upon comparison of proposed project effects with applicable state, local, or national ambient air quality standards, or the potential exceedance of prevention of significant deterioration increments. The more stringent of the standards serve as the comparison criteria. The comparison of project toxic pollutants includes guidelines or standards adopted or proposed by each state.

Acoustic impacts are assessed qualitatively on the basis of the potential degree of change in noise levels at sensitive receptors with respect to ambient conditions.

### Water Resources

**Surface Water.** The surface water impacts are assessed based on water consumption and wastewater discharge for both construction and operation phases. Changes in the annual low flows of surface water resulting from proposed withdrawals and discharges are determined. The existing water supply is evaluated to determine if sufficient quantities are available to support an increased demand by comparing projected increases with the capacity of the supplier and existing water rights, agreements, or allocations. The assessment of water quality impacts from wastewater (sanitary and process) and stormwater runoff qualitatively addresses potential impacts to the receiving waters.

Floodplains impacts are assessed based on whether any of the proposed tritium supply technologies and recycling facilities are located within a floodplain. Where possible, the proposed location is compared with the 500-year floodplain.

**Groundwater.** Groundwater resource impacts are assessed based on the effects on aquifers, groundwater usage, and groundwater quality within the regions. Total groundwater use at the facility and projections of future usage are added to project water requirements to determine the short- and long-term impacts associated with construction and operation and dewatering withdrawals. Impacts of groundwater withdrawals on existing contaminant plumes because of construction and facility operation are assessed.

### Geology and Soils

Impacts to the geological environment are assessed based on the destruction of or damage to unique geological features and subsidence caused by groundwater withdrawal, landslide, or shifting. Potential seismic impacts are assessed based on the locations of capable faults and the history of the seismicity of the site areas. Soil types at the proposed project sites are described and the capability of supporting construction of the proposed structures assessed.

### Biotic Resources

Potential impacts are assessed based on the degree to which various habitats or species could be affected by the project. Where possible, impacts are evaluated with respect to Federal and state protection regulations and standards.

**Terrestrial Resources.** Impacts to wildlife are based on plant community loss, which is associated with animal habitat. Also evaluated is the disturbance, displacement, or loss of wildlife. Based on expected releases and the results of past studies, impacts of radionuclides on site biota were not evaluated.

**Wetlands.** Impacts are assessed based on the nearness of wetlands to project areas and with the knowledge that standard construction erosion and sedimentation control measures would be implemented. Impacts from increased flows are assessed

based on a comparison of expected discharge rates with present stream flow rates.

**Aquatic Resources.** Impacts as a result of sedimentation, increased flows, and effluent discharges are assessed in the same manner as wetlands. Impacts as a result of impingement and entrainment are assessed based on comparison of stream flow and intake volumes.

**Threatened and Endangered Species.** A list of species potentially present at each site using information obtained from the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and appropriate state agencies, along with site environmental and engineering data, is used to assess whether the various technologies would impact any plant or animal.

### Cultural and Paleontological Resources

**Prehistoric and Historic Resources.** Impacts are assessed by considering whether the proposed action could substantially add to existing disturbance of resources in the areas, adversely affect National Register of Historic Places (NRHP) eligible resources, or cause loss of or destruction to important prehistoric resources.

**Native American Resources.** Impacts are assessed by considering whether the proposed action has the potential to affect sites important for their position in the Native American physical universe or belief system, or the possibility of reducing access to traditional use areas or sacred sites.

**Paleontological Resources.** Impact assessments for paleontological resources are based on the numbers and kinds of resources that could be affected as well as the quality of fossil preservation in a given deposit.

### Socioeconomics

The assessment of impacts on local and regional socioeconomic conditions and factors include population, employment, economy, housing, public finance, and transportation. The impact assessment is based on the degree to which changes in employment and population affect the local economy, housing market, public finance, and transportation. The changes to these factors are projected to the year 2030 because it is assumed that after 2030 the impacts associated with the alternatives are negligibly different from the 2030 conditions.

### Radiation and Hazardous Chemical Environment

The health effects are determined for each technology by identifying the types and quantities of material to which one is exposed, estimating doses, and then calculating the resultant health effect. The impacts on human health for workers and the public during normal operation and postulated accidents from various alternatives are assessed. Models such as GENII and MACCS for airborne and liquid radioactive releases; CHEM-PLUS for fire and explosions; and SLAB for hazardous chemical releases were used to project impacts. Atmospheric dispersion modeling performed for the air quality section is also utilized in the evaluation of impacts to workers from radiological and hazardous chemicals.

Experience from past and current operations that are similar to future operation is used to estimate the radiological health impacts to workers. Models are used to estimate the worker chemical exposure dose since no individual exposure data are available. Public health impacts could result from exposure to radioactive or hazardous chemical materials released during operation. Modeling is used to estimate the type and amount of material released and the associated radiological and chemical doses. These doses are converted to health effects using appropriate health risk estimators.

The relative consequences of postulated accidents in the evaluation of each alternative are assessed. The accident analysis involves less detail than a formal Probabilistic Risk Assessment and only addresses bounding accidents (high consequence, low probability) and a representative spectrum of possible operational accidents (low consequence but high probability of occurrence). The technical approach for the selection of accidents is consistent with the DOE Office of NEPA Oversight Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements guidance (May 1993), which recommends consideration of two major categories of accidents: within design basis accidents and beyond design basis accidents.

Risk is defined as the mathematical product of the probability and consequence of an accident. The risk-contributing scenarios consider both design-basis and severe accidents. The specific accidents consider the types of facilities.

### WASTE MANAGEMENT

The analysis addresses the waste types and waste volumes projected to be generated from the various supply technologies and recycling facilities at each site. Impacts are assessed in the context of site practices for treatment, storage, and disposal plus the applicable regulatory setting of the *Atomic Energy Act; Federal Facility Compliance Act; Resource Conservation and Recovery Act; Clean Air Act; Clean Water Act; Toxic Substances Control Act; Safe Drinking Water Act; Comprehensive Environmental Response, Compensation, and Liability Act*; *National Environmental Policy Act*; and DOE orders.

Pantex is the only site under consideration that does not have existing onsite low-level waste disposal; the number of additional shipments required to transport low-level waste from Pantex to a DOE low-level waste disposal facility is estimated. The risk associated with additional shipments is also addressed.

### INTERSITE TRANSPORTATION

The intersite transportation assessment was based on the transport mode, weight of material, curies, proximity dose rates (transport index), type of package, number of shipments, and distance. Health impacts are presented for transportation of tritium associated with tritium operations for normal (incident-free) transportation and accident conditions.

## ENVIRONMENTAL IMPACTS

In accordance with Council on Environmental Quality (CEQ) regulations, the environmental consequences discussions provide the analytical detail for comparisons of environmental impacts associated with the various tritium supply technologies and recycling facilities.

Table ES–1, at the end of this summary, presents a summary comparison of environmental impacts of the tritium supply and recycling alternatives. Impacts associated with collocation of a tritium supply and recycling alternative are evaluated for every site except SRS. At SRS, impacts are evaluated for a tritium supply with upgraded recycling and a tritium upgrade. In addition, impacts associated with tritium supply alone alternatives are evaluated for all the candidate sites except SRS. A supply alone alternative does not exist for SRS because of existing recycling facilities. The tritium upgrade is part of the supply alone alternatives at the other four candidate sites (INEL, NTS, ORR, and Pantex). For the supply alone alternatives, there would be minor impacts associated with upgrading the facilities at SRS.

For comparison purposes, environmental concentrations of emissions and other potential environmental effects are presented with appropriate regulatory standards or guidelines. However, the compliance with regulatory standards is not an assessment of the significance or severity of the environmental impact for NEPA purposes. The purpose of the analysis of environmental consequences is to identify the potential for environmental impacts. The Tritium Supply and Recycling PEIS (Volume I) discusses in detail the environmental assessment methods used and the factors considered in assessing environmental impacts.

To satisfy the requirements of the NEPA, No Action is presented for comparison with the action alternatives. Under No Action (2010), DOE would not establish a new tritium supply capability, the current inventory of tritium would decay, and DOE would not meet stockpile requirements of tritium. Sites would continue waste management programs to meet the legal requirements and commitments in formal agreements and would proceed with cleanup activities. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for the year 2010 and beyond.

To minimize repetition and be as brief and concise as possible, the comparison of alternatives in Table ES–1 concentrates on the areas in which the public has expressed considerable interest and on programmatic factors important to DOE decision-making. Accordingly, the following resources are compared in Table ES–1:

- Land Resources
- Site Infrastructure
- Water Resources (Surface Water and Groundwater)
- Biotic Resources (Wetlands, Aquatic Resources, and Threatened and Endangered Species and/or Species of Concern)
- Socioeconomics (Employment during construction and operation and Unemployment during operation)
- Radiological and Hazardous Chemical Impacts During Normal Operations
- Radiological Impacts–Accidents
- Waste Management
- Intersite Transportation

For the other resource areas summarized below, the environmental impacts do not vary significantly from site to site or technology to technology.

**Visual Resources:** Visual impacts may occur at NTS, ORR, or SRS. There would be no impacts to visual resources at INEL or Pantex. The use of a wet cooling system at ORR or SRS would produce some visible cooling tower plumes during certain weather conditions.

**Air Quality and Acoustics:** Construction activities would result in exceedance of 24-hour $PM_{10}$ and TSP standards. At all sites, air pollutant concentrations would increase during operation but would be within standards, and noise levels would increase during both construction and operation.

**Flood Plains:** No construction would take place in areas designated as 100-year flood plains at any site, or in areas designated as 500-year flood plains at INEL. NTS, ORR, Pantex, and SRS would require 500-year flood plain assessments.

**Geology and Soils:** There would be no impacts associated with geological conditions and no impacts to soils except for the disturbed areas.

**Terrestrial Resources:** The impacts to terrestrial resources would vary by the acreage disturbed during construction, and some salt drift impacts are possible with wet cooling systems.

**Cultural and Paleontological Resources:** Some NRHP-eligible resources may occur within the proposed site; Native American resources may be affected by land disturbance and audio or visual intrusions; and some paleontological resources may be affected by construction excavations deeper than 50 feet.

**Other Socioeconomic Issues:** Unemployment would decrease slightly in the economic study area at all sites during construction. Population and housing demand would increase slightly in the economic study area during construction and operation, as would per capita income. Revenues and expenditures for most region-of-influence counties, cities, and school districts would increase during construction and operation. Traffic conditions would worsen slightly during construction and operation on main access routes to the sites.

## MULTIPURPOSE ("TRIPLE PLAY") REACTOR

The Department's Office of Fissile Materials Disposition is preparing a PEIS addressing the issue of how to dispose of plutonium that is excess to nuclear weapons requirements. Among the alternatives expected to be analyzed in the Storage and Disposition of Weapons-Usable Fissile Materials PEIS is the use of plutonium as a fuel in existing, modified, or new nuclear reactors.

The nuclear reactors evaluated for tritium production in the Tritium Supply and Recycling PEIS utilize uranium as the fuel source, and the analysis in this PEIS is based on that design. Nonetheless, it is technically feasible to also use plutonium or plutonium-uranium oxide (mixed-oxide) fuel for a tritium production reactor. Congress and commercial entities have expressed interest in developing a multipurpose ("triple play") reactor that could produce tritium, "burn" plutonium, and generate revenues through the sale of electric power. Only the ALWR and MHTGR would be capable of performing the triple play missions; the potential environmental impacts from these triple play reactors are summarized below.

**Advanced Light Water Reactor.** If an ALWR were used to burn plutonium, the major contributions to potential environmental impacts would be from a new plutonium pit disassembly/conversion/mixed-oxide fuel fabrication facility. Such a facility could disturb up to 129 acres of land, and require a peak construction force of 550 during the peak year of the 6 year construction period.

During operation, this facility would require approximately 10 percent as much water as a large ALWR at a dry site, and would employ as many workers as the ALWR. Radiological exposures to workers during normal operation would be kept as low as reasonably achievable, and would not be expected to exceed 50 mrem per worker per year. If all 650 workers were exposed to such a dose, a highly conservative assumption, 0.52 latent cancer fatalities (less than one) would be expected over the 40 year operation life of the facility. The goal for the facility for public radiation exposure would be not to exceed 1.0 mrem effective dose equivalent per year.

Safety analysis reports have not been prepared for this facility. However, bounding accident scenarios have been identified from safety analysis reports for similar plants. Criticality accidents, explosions, and fires could occur in such a facility, and release radiation to the environment. Any postulated releases to the environment would increase the risk and number of latent cancers to a surrounding population.

Using a mixed-oxide fuel in an ALWR would have no major effect on reactor operations, and therefore, impacts would not be expected to change significantly from those associated with utilizing a uranium fueled reactor. This is based on a study conducted by the NRC, the *Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed-Oxide Fuel in Light Water Reactors*.

**Modular High Temperature Gas-Cooled Reactor.** To burn plutonium in a modular gas-cooled reactor, a plutonium pit disassembly/conversion/plutonium-oxide fuel fabrication facility would also be needed, and the environmental impacts from such a facility are expected to be approximately the same as those described for the similar facility to support a multipurpose ALWR. In a plutonium-fueled gas-cooled reactor, however, tritium production decreases significantly. Thus, twice as many reactor modules would be necessary in order to produce the steady-state tritium requirements. This doubling of reactor modules would be the major contributor to potential environmental impacts for this scenario.

Overall, building twice as many reactor modules could double most environmental impacts. Some construction impacts (land distributed, construction duration, and peak construction workforce) might be less than double because of economies of scale and shared support infrastructure. Depending upon the particular site, some impacts could be significant.

During operation of twice as many reactor modules, water requirements could increase by 80 percent. This could cause adverse impacts to groundwater at dry sites. The expected workforce increase would approximately double any socioeconomic impacts and radiation doses to workers. Radiation exposure to the public from normal operation might also double. Due to the lack of source term data and accident behavior for a plutonium-fueled gas-cooled reactor, postulated accidents and resulting radiological impacts cannot be determined at this time. Spent fuel generation would also double with the addition of twice as many reactor modules.

## AGENCY PREFERRED ALTERNATIVE

The CEQ regulations require that an agency identify its preferred alternative, if one or more exists, in the Draft Environmental Impact Statement (40 CFR 1502.14(e)). The preferred alternative is the alternative that the agency believes would fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. Consequently, to identify a preferred alternative, the Department has developed information on potential environmental impacts, and is continuing to develop costs, technical risks, and schedule risks for the alternatives under consideration. For this draft PEIS, no preferred alternatives exist for (1) tritium supply technology; (2) tritium supply site; or (3) tritium recycling site.

The final PEIS will include any preferred alternatives. However, the Department may choose to identify a preferred alternative prior to publication of the final PEIS. The Record of Decision will describe the Department's decision for tritium supply and recycling.

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 1 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Land Resources—No Action** | | | | |
| • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. | • Under No Action there would be no impacts to land use or visual resources. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • The land disturbance by technology:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres<br>Recycling: 202 acres | • The land disturbance by technology:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres<br>Recycling: 202 acres | • The land disturbance by technology:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres<br>Recycling: 202 acres | • The land disturbance by technology:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres<br>Recycling: 202 acres | • The land disturbance by technology:<br>HWR: 260 acres<br>MHGTR: 360 acres<br>ALWR: 350 acres<br>APT: 173 acres<br>Recycling upgrade:<br>0 acres |
| **Site Infrastructure—No Action** | | | | |
| • Under No Action the peak electrical load requirement would reduce by 51 MWe. Annual energy consumption would remain the same. | • Under No Action the peak electrical load requirement would reduce by 7MWe. Annual energy consumption would remain the same. | • Under No Action the peak electrical load requirement would reduce by 1,304 MWe. Annual energy consumption would reduce by 11,641,800 MWh/yr. | • Under No Action the peak electrical load requirement would reduce by 1 MWe. Annual energy consumption would reduce by 7,000 MWh/yr. | • Under No Action the peak electrical load requirement would reduce by 214 MWe. Annual energy consumption would reduce by 878,000 MWh/yr. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • The increase in the current site electrical requirement (MWe) for each technology:<br>HWR: 34<br>MHGTR: 11<br>Large ALWR: 105<br>Small ALWR: 40<br>Full APT: 515<br>Phased APT: 320 | • The increase in the current site electrical requirement (MWe) for each technology:<br>HWR: 78<br>MHGTR: 55<br>Large ALWR: 149<br>Small ALWR: 84<br>Full APT: 559<br>Phased APT: 364 | • The change in current capacity (MWe) for each technology:<br>HWR: 1,237 less<br>MHGTR: 1,252 less<br>Large ALWR: 1,192 less<br>Small ALWR: 1,236 less<br>Full APT: 738 less<br>Phased APT: 933 less | • The increase in the current site electrical requirement (MWe) for each technology:<br>HWR: 84<br>MHGTR: 61<br>Large ALWR: 155<br>Small ALWR: 90<br>Full APT: 565<br>Phased APT: 370 | • The change in current capacity (MWe) for each technology:<br><br>HWR: 163 less<br>MHGTR: 178 less<br>Large ALWR: 118 less<br>Small ALWR: 162 less<br>Full APT: 336 (increase)<br>Phased APT:<br>141 (increase) |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 2 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • The percent of the power pool capacity margin:<br>HWR: 0.62<br>MHTGR: 0.45<br>Large ALWR: 1.14<br>Small ALWR: 0.67<br>Full APT: 4.15<br>Phased APT: 2.72 | • The percent of the power pool capacity margin:<br>HWR: 0.72<br>MHTGR: 0.53<br>Large ALWR: 1.32<br>Small ALWR: 0.77<br>Full APT: 4.79<br>Phased APT: 3.14 | • The percent of the power pool capacity margin:<br>HWR: 1.47<br>MHTGR: 1.14<br>Large ALWR: 2.46<br>Small ALWR: 1.50<br>Full APT: 12.44<br>Phased APT: 8.15 | • The percent of the power pool capacity margin:<br>HWR: 0.64<br>MHTGR: 0.47<br>Large ALWR: 1.18<br>Small ALWR: 0.69<br>Full APT: 4.28<br>Phased APT: 2.80 | • The percent of the power pool capacity margin:<br>HWR: 0.49<br>MHTGR: 0.35<br>Large ALWR: 0.92<br>Small ALWR: 0.50<br>Full APT: 5.27<br>Phased APT: 3.40 |
| • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • The supply alone would reduce the peak load requirement above by 16 MWe for all technologies. | • No supply alone. |
| | | **Water Resources—No Action** | | |
| • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. | • Under No Action there would be no impacts to water resources. |
| | | **Collocated Tritium Supply and Recycling** | | |
| • Surface water would not be used during construction. | • Surface water would not be used during construction. | • The construction surface water use (MGY) and corresponding percentage increase by technology:<br>HWR: 23 (1 percent)<br>MHTGR: 19 (1 percent)<br>Large ALWR: 35 (2 percent)<br>Small ALWR: 22 (1 percent)<br>APT: 10 (<1 percent) | • Surface water would not be used during construction. | • Surface water would not be used during construction. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 3 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • The construction groundwater use (MGY) by technology:<br>HWR: 23<br>MHTGR: 19<br>Large ALWR: 35<br>Small ALWR: 22<br>APT: 10 | • The construction groundwater use (MGY) by technology:<br>HWR: 23<br>MHTGR: 19<br>Large ALWR: 35<br>Small ALWR: 22<br>APT: 10 | • Groundwater would not be affected by construction or operation. | • The construction groundwater use (MGY) by technology:<br>HWR: 23<br>MHTGR: 19<br>Large ALWR: 35<br>Small ALWR: 22<br>APT : 10 | • The construction groundwater use (MGY) by technology:<br>HWR: 21<br>Large ALWR: 33<br>Small ALWR: 20<br>MHTGR: 18<br>APT: 8 |
| • The total percent of groundwater use increase during construction by technology:<br>HWR: 1<br>MHTGR: 1<br>Large ALWR: 2<br>Small ALWR: 1<br>Full APT: <1<br>Phased APT: <1 | • The total percent of groundwater use increase during construction by technology:<br>HWR: 4<br>MHTGR: 3<br>Large ALWR: 6<br>Small ALWR: 3<br>Full APT: 2<br>Phased APT: 2 | • No groundwater use. | • The total percent of groundwater use increase during construction by technology:<br>HWR: 8<br>MHTGR: 7<br>Large ALWR: 2<br>Small ALWR: 1<br>Full APT: 3<br>Phased APT: 3 | • The total percent of groundwater use increase during construction by technology:<br>HWR: 1<br>MHTGR: 1<br>Large ALWR: 1<br>Small ALWR: 1<br>Full APT: <1<br>Phased APT: <1 |
| • Surface water would not be used during operation. | • Surface water would not be used during operation. | • The operation surface water use (MGY) and corresponding percentage increase by technology:<br>HWR: 5,914 (320 percent)<br>MHTGR: 4,044 (219 percent)<br>Large ALWR: 16,014 (866 percent)<br>Small ALWR: 7,214 (391 percent)<br>Full APT: 2,656 (144 percent)<br>Phased APT: 1,705 (92 percent) | • Surface water would not be used during operation. | • The operation surface water use (MGY) and corresponding percentage increase by technology:<br>HWR: 5,830 (29 percent)<br>MHTGR: 4,030 (20 percent)<br>Large ALWR: 15,530 (78 percent)<br>Small ALWR : 7,130 (36 percent)<br>Full APT: 2,665 (13 percent)<br>Phased APT: 1,714 (9 percent) |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 4 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • No blowdown discharges to surface water. | • No blowdown discharges to surface water. | • Blowdown discharges (MGY) to surface waters by technology:<br>HWR: 2,304<br>MHTGR: 1,608<br>Large ALWR: 6,192<br>Small ALR: 2,808<br>Full APT: 528<br>Phased APT: 288 | • No blowdown discharges to surface water. | • Blowdown discharges (MGY) to surface waters by technology:<br>HWR: 2,304<br>MHTGR: 1,608<br>Large ALWR: 6,192<br>Small ALWR: 2,808<br>Full APT: 528<br>Phased APT: 288 |
| • Operation groundwater requirements (MGY) and corresponding percentage increase by technology:<br>HWR: 62 (3 percent)<br>MHTGR: 44 (2 percent)<br>Large ALWR: 104 (5 percent)<br>Small ALWR: 64 (3 percent)<br>Full APT: 2,656 (132 percent)<br>Phased APT: 1,705 (85 percent)<br>Total groundwater use for HWR, MHTGR, and ALWR would be approximately 18 percent of the INEL groundwater allotment; the APT approximately 41 percent. | • Operation groundwater requirements (MGY) and corresponding percentage increase by technology:<br>HWR: 62 (8 percent)<br>MHTGR: 44 (5 percent)<br>Large ALWR: 104 (14 percent)<br>Small ALWR: 64 (8 percent)<br>Full APT: 2,656 (417 percent)<br>Phased APT: 1,705 (267 percent)<br>The HWR, MHTGR, and ALWR would not adversely affect aquifer water levels. The APT withdrawals may exceed the aquifer lowest estimated recharge rate, but would not be expected to impact offsite springs. | • Groundwater would not be used for operation. | • Operation groundwater requirements (MGY) and corresponding percentage increase by technology:<br>HWR: 62 (17 percent)<br>MHTGR: 44 (10 percent)<br>Large ALWR: 104 (31 percent)<br>Small ALWR: 64 (17 percent)<br>Full APT: 2,656 (924 percent)<br>Phased APT: 1,705 (591)<br>Drawdowns would adversely affect aquifer water levels. | • Operation groundwater requirements (MGY) and correspondencing percentage increase by technology:<br>HWR: 69 (2 percent)<br>MHTGR: 51 (2 percent)<br>Large ALWR: 111 (3 percent)<br>Small ALWR: 71 (3 percent)<br>Full APT: 28 (2 percent)<br>Phased APT: 28 (2 percent) |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 5 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • The groundwater requirement would be 1.5 MGY less than for collocation during construction and 14 MGY less during operation for all technologies. No surface water would be used. | • The groundwater requirement would be 1.5 MGY less than for collocation during construction and 14 MGY less during operation for all technologies. No surface water would be used. | • No groundwater would be used. Total surface water requirement would be 1.5 MGY less than for collocation during construction and 14 MGY less during operation for all technologies. | • The groundwater requirement would be 1.5 MGY less than for collocation during construction and 14 MGY less during operation for all technologies. No surface water would be used. | • No tritium supply alone. |
| | | **Biotic Resources—No Action** | | |
| • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. | • Under No Action there would be no impacts to biotic resources. |
| | | **Collocated Tritium Supply and Recycling** | | |
| • Wetlands and aquatic resources would not be affected. | • Wetlands and aquatic resources would not be affected. | • Without appropriate mitigation measures, increased stream flow from operational discharges could affect wetland and aquatic plant communities. | • Without appropriate mitigation measures, playa wetlands could be degraded by discharges, aquatic resources would not be affected. | • Without appropriate mitigation measures, construction and operational discharges to an onsite stream could affect wetland and aquatic communities. |
| • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidates or state-listed species may be affected. | • One Federal-listed, threatened species, the desert tortoise, could be affected during construction and operation. Several Federal candidate or state-listed species may be affected. | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidates or state-listed species may be affected. | • One Federal-listed, threatened species, the bald eagle, and six Federal candidate or state-listed species may be affected by construction activities. | • No Federal-listed, threatened, or endangered species would be affected during construction or operation, but several Federal candidates or state-listed species may be affected. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 6 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The ferruginous hawk would lose foraging habitat equal to the amount of land disturbed for each technology during construction and operation. The Townsend's western big-eared bat may roost and forage throughout the disturbed area during construction and forage at stormwater retention ponds during operation. | • The ferruginous hawk could lose foraging habitat equal to the amount of land disturbed for each technology during construction and operation. The loggerhead shrike could lose foraging and breeding habitats as well. Neither species should be adversely affected due to the large extent of nearby suitable habitat. | • Four state-listed raptors would lose potential nesting and foraging habitat equal to the amount of disturbed land for each technology; however this type of habitat is abundant in the area. The Tennessee dace and hellbender, both state-listed, could be affected by construction. | • The black tern, white-faced ibis, ferruginous hawk, loggerhead shrike, and bald eagle could lose foraging and/or nesting habitat equal to the amount of land disturbed for each technology during construction. The swift fox would lose potential foraging and denning habitat. The Texas horned lizard could be impacted during land clearing activities. | • The potentially affected species include the awned meadow-beauty, green-fringed orchid, Florida false loosestrife, beakrush, star-nosed mole and the eastern tiger salamander, which would lose foraging habitat equal to the disturbed land during construction for each technology. |
| **Socioeconomics—No Action** | | | | |
| • Under No Action INEL employment decreased by 1,000 persons between 1990 and 1994 to 10,100 persons, and will remain at this level through the year 2020. | • Under No Action NTS employment decreased by 1,170 persons between 1990 and 1994 to 6,850 persons, and will remain at this level through the year 2020. | • Under No Action ORR employment decreased by 300 persons between 1990 and 1994 to 15,000 persons, and it will remain at this level through the year 2020. | • Under No Action Pantex employment increased by 1,000 persons between 1990 and 1994 to 3,400 persons. It will decrease to 1,790 in 2010 and is expected to remain at this level through 2020. | • Under No Action SRS employment decreased by 2,000 persons between 1990 and 1994 to 20,300 persons. It will decrease to 16,900 by 2010 and is expected to remain at this level through the year 2020. |
| • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually through the year 2010, and then decrease by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually through the year 2009, and then continue to increase by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by 1 percent annually through the year 2009, and then grow by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually through the year 2020. | • Under No Action employment in the economic study area is expected to grow by less than 1 percent annually between 2001 and 2020. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 7 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **No Action** | | |
| • Under No Action unemployment is expected to be at 6.4 percent between the years 2001 and 2020. Per capita income is expected to increase from $17,800 to $20,900. | • Under No Action unemployment is expected to be at 5 percent between the years 1999 and 2020. Per capita income is expected to increase from $23,600 to $25,100. | • Under No Action unemployment is expected to be at 6.2 percent between the years 2001 and 2020. Per capita income is expected to increase from $17,900 to $20,700. | • Under No Action unemployment is expected to be at 4.6 percent between the years 2001 and 2020. Per capita income is expected to increase from $22,300 to $25,700. | • Under No Action unemployment is expected to be at 4.8 percent between the years 2001 and 2020. Per capita income is expected to increase from $18,300 to $21,000. |
| • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2010. | • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2020. | • Under No Action population and housing annual average increase is expected to be 1 percent through the year 2009 and less than 1 percent between 2010 and 2020. | • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2020. | • Under No Action population and housing annual average increase is expected to be less than 1 percent through the year 2010. |
| • Population is expected to reach 207,300 in 2010 and 215,200 in 2020. | • Population is expected to reach 1,020,900 in 2010 and 1,103,500 in 2020. | • Population is expected to reach 561,000 in 2010 and 586,000 in 2020. | • Population is expected to reach 205,100 in 2010 and 209,000 in 2020. | • Population is expected to reach 454,900 in 2010 and 473,000 in 2020. |
| • Under No Action total revenues and expenditures for ROI counties, cities and school districts is expected to increase by an annual average of less than 1 percent from 2001 to 2020. | • Under No Action total revenues and expenditures for ROI counties, cities and school districts is expected to increase by an annual average of less than 1 percent to 4 percent between 2001 and 2005, and by 1 to 2 percent between 2005 and 2010. Between 2010 and 2020, annual increases of less than 1 percent are expected. | • Under No Action total revenues and expenditures for ROI counties, cities and school districts is expected to increase by an annual average of approximately 1 percent or less through 2010 to 2020. | • Under No Action total revenues and expenditures for ROI counties, cities and school districts is expected to increase by an annual average of less than 1 percent through 2020. | • Under No Action total revenues and expenditures for ROI counties, cities and school districts is expected to increase by an annual average of less than 1 percent through 2020. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 8 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The increase during peak construction of employment in the economic study area by technology:<br>HWR: 7,500<br>MHTGR: 7,200<br>ALWR: 10,800<br>APT: 4,800 | • The increase during peak construction of employment in the economic study area by technology:<br>HWR: 9,500<br>MHTGR: 7,900<br>ALWR: 13,700<br>APT: 6,000 | • The increase during peak construction of employment in the economic study area by technology:<br>HWR: 8,000<br>MHTGR: 9,000<br>ALWR: 12,000<br>APT: 5,300 | • The increase during peak construction of employment in the economic study area by technology:<br>HWR: 7,600<br>MHTGR: 7,300<br>ALWR: 11,000<br>APT: 4,800 | • The increase during peak construction of employment in the economic study area by technology:<br>HWR: 7,200<br>MHTGR: 6,900<br>ALWR: 11,700<br>APT: 4,200 |
| • The increase during full operation of employment in the economic study area by technology:<br>HWR: 4,900<br>MHTGR: 4,900<br>ALWR: 4,700<br>APT: 4,100 | • The increase during full operation of employment in the economic study area by technology:<br>HWR: 5,500<br>MHTGR: 5,500<br>ALWR: 5,200<br>APT: 4,600 | • The increase during full operation of employment in the economic study area by technology:<br>HWR: 5,200<br>MHTGR: 5,100<br>ALWR: 4,900<br>APT: 4,300 | • The increase during full operation of employment in the economic study area by technology:<br>HWR: 5,500<br>MHTGR: 6,000<br>ALWR: 5,000<br>APT: 4,400 | • The increase during full operation of employment in the economic study area by technology:<br>HWR: 2,400<br>MHTGR: 2,300<br>ALWR: 2,100<br>APT: 1,600 |
| • Unemployment in the economic study area during full operation by technology decreases by:<br>HWR: 1.8 percent<br>MHTGR: 1.8 percent<br>ALWR: 1.7 percent<br>APT: 1.5 percent | • Unemployment in the economic study area during full operation by technology decreases by:<br>HWR: 0.7 percent<br>MHTGR: 0.7 percent<br>ALWR: 0.6 percent<br>APT: 0.6 percent | • Unemployment in the economic study area during full operation by technology decreases by:<br>HWR: 0.6 percent<br>MHTGR: 0.6 percent<br>ALWR: 0.6 percent<br>APT: 0.5 percent | • Unemployment in the economic study area during full operation by technology decreases by:<br>HWR: 2.1 percent<br>MHTGR: 2.1 percent<br>ALWR: 1.9 percent<br>APT: 1.8 percent | • Unemployment in the economic study area during full operation by technology decreases by:<br>HWR: 0.3 percent<br>MHTGR: 0.2 percent<br>ALWR: 0.2 percent<br>APT: 0.2 percent |
| **Radiological and Hazardous Chemical Impacts During Normal Operation—No Action** | | | | |
| • Under No Action for emissions of radiation, the dose to the maximally exposed member of the public from 1 year of operation is $6.0 \times 10^{-3}$ mrem. The risk of fatal cancer from 40 years of operation is $1.2 \times 10^{-7}$. | • Under No Action for emissions of radiation, the dose to the maximally exposed member of the public from 1 year of operation is 0.04 mrem. The risk of fatal cancer from 40 years of operation is $8.1 \times 10^{-7}$. | • Under No Action for emissions of radiation, the dose to the maximally exposed member of the public from 1 year of operation is 3.9 mrem from atmospheric release and 14 mrem from liquid release. The risk of fatal cancer from 40 years of operation is $7.8 \times 10^{-5}$ and $2.7 \times 10^{-4}$ respectively. | • Under No Action for emissions of radiation, the dose to the maximally exposed member of the public from 1 year of operation is $1.3 \times 10^{-3}$ mrem. The risk of fatal cancer from 40 years of operation is $2.6 \times 10^{-8}$. | • Under No Action for emissions of radiation, the dose to the maximally exposed member of the public from 1 year of operation is 2.8 mrem from atmospheric release and 0.077 from liquid release. The risk of fatal cancer from 40 years of operation is $5.6 \times 10^{-5}$ and $1.5 \times 10^{-6}$ respectively. |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 9 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **No Action** | | |
| • The population dose of 0.037 person-rem from total site operations in 2030 would result in 7.4 x $10^{-4}$ fatal cancer over 40 years of operation. | • The population dose of 8.2 x $10^{-3}$ person-rem from total site operations in 2030 would result in 1.6x$10^{-4}$ fatal cancer over 40 years of operation. | • The population dose of 57 person-rem from total site operations in 2030 would result in 1.1 fatal cancer over 40 years of operation. | • The population dose of 5.7x$10^{-4}$ person-rem from total site operations in 2030 would result in 1.1x$10^{-5}$ fatal cancer over 40 years of operation. | • The population dose of 250 person-rem from total site operations in 2030 would result in 4.9 fatal cancers over 40 years of operation. |
| • Under No Action the average annual dose to a site worker is 30 mrem with a risk of fatal cancer of 4.8 x $10^{-4}$ from 40 years of operation. The annual dose of 220 person-rem to total site workforce would result in 3.5 fatal cancers over 40 years of operation. | • Under No Action the average annual dose to a site worker is 5 mrem with a risk of fatal cancer of 7.8 x $10^{-5}$ from 40 years of operation. The annual dose of 3 person-rem to total site workforce would result in 0.048 fatal cancer over 40 years of operation. | • Under No Action the average annual dose to a site worker is 17 mrem with a risk of fatal cancer of 2.8 x $10^{-4}$ from 40 years of operation. The annual dose of 320 person-rem to total site workforce would result in 5.1 fatal cancers over 40 years of operation. | • Under No Action the average annual dose to a site worker is 15 mrem with a risk of fatal cancer of 2.4 x $10^{-4}$ from 40 years of operation. The annual dose of 37 person-rem to total site workforce would result in 0.59 fatal cancers over 40 years of operation. | • Under No Action the average annual dose to a site worker is 32 mrem with a risk of fatal cancer of 5.2 x $10^{-4}$ from 40 years of operation. The annual dose of 480 person-rem to total site workforce would result in 7.7 fatal cancers over 40 years of operation. |
| • Under No Action for emission of hazardous chemicals, the chemical Hazard Index is 1.7 x $10^{-4}$ with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.021 with no cancer risk. | • Under No Action for emission of hazardous chemicals, the chemical Hazard Index is 0 with no cancer risk to the maximally exposed member of the public or site worker. | • Under No Action for emission of hazardous chemicals, the chemical Hazard Index is 0.36 with no cancer risk to the maximally exposed member of the public. The site worker Hazard Index is 0.26 with no cancer risk. | • Under No Action for emission of hazardous chemicals, the chemical Hazard Index is 0.03 with a cancer risk of 1.1 x $10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 0.49 with a cancer risk of 0.01.<br><br>The maximally exposed member of the public and site worker cancer risk both exceed the typical threshold of regulatory concern of 1.0x$10^{-6}$. | • Under No Action for emission of hazardous chemicals the chemical Hazard Index is 0.70 with a cancer risk of 3.3 x $10^{-5}$ to the maximally exposed member of the public. The site worker Hazard Index is 1.8 and the cancer risk is 5.9 x $10^{-3}$.<br><br>The Hazard Index value for the public is within regulatory limits, however, the worker Hazard Index exceeds OSHA's action level of 1.0. The cancer risk to both the public and site worker exceeds the typical threshold of regulatory concern of 1.0x$10^{-6}$. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 10 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The annual dose to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology:<br><br>HWR: 0.29 mrem ($5.9 \times 10^{-6}$)<br>MHTGR: 0.19 mrem ($3.8 \times 10^{-6}$)<br>Large and Small ALWR: 0.36 mrem ($7.3 \times 10^{-6}$)<br><br>APT (He-3): 0.11 mrem ($2.3 \times 10^{-6}$)<br>APT (SILC): 0.16 mrem ($3.3 \times 10^{-6}$) | • The annual dose to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology:<br><br>HWR: 0.31 mrem ($6.2 \times 10^{-6}$)<br>MHTGR: 0.21 mrem ($4.1 \times 10^{-6}$)<br>Large and Small ALWR: 0.40 mrem ($8.0 \times 10^{-6}$)<br><br>APT (He-3): 0.13 mrem ($2.6 \times 10^{-6}$)<br>APT (SILC): 0.18 mrem ($3.6 \times 10^{-6}$) | • The annual dose to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology:<br><br>HWR: 7.1 mrem ($1.4 \times 10^{-4}$)<br>MHTGR: 5.7 mrem ($1.1 \times 10^{-4}$)<br>Large ALWR: 8.8 mrem ($1.8 \times 10^{-4}$)<br>Small ALWR: 7.6 mrem ($1.5 \times 10^{-4}$)<br>APT (He-3): 4.3 mrem ($8.6 \times 10^{-5}$)<br>APT (SILC): 5.0 mrem ($9.9 \times 10^{-5}$) | • The annual dose to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology:<br><br>HWR: 3.8 mrem ($7.6 \times 10^{-5}$)<br>MHTGR: 2.4 mrem ($4.8 \times 10^{-5}$)<br>Large ALWR: 4.9 mrem ($9.8 \times 10^{-5}$)<br>Small ALWR: 4.8 mrem ($9.6 \times 10^{-5}$)<br>APT (He-3): 1.4 mrem ($2.9 \times 10^{-5}$)<br>APT (SILC): 2.1 mrem ($4.2 \times 10^{-5}$) | • The annual dose to the maximally exposed member of the public from total site operations from atmospheric release and the associated (risk of fatal cancer) from 40 years of operation by technology:<br>HWR: 3.4 mrem ($6.9 \times 10^{-5}$)<br>MHTGR: 3.0 mrem ($5.9 \times 10^{-5}$)<br>Large ALWR: 3.9 mrem ($7.8 \times 10^{-5}$)<br>Small ALWR: 3.6 mrem ($7.1 \times 10^{-5}$)<br>APT (He-3): 2.5 mrem ($4.9 \times 10^{-5}$)<br>APT (SILC): 2.8 mrem ($5.6 \times 10^{-5}$) |
| • No liquid releases. | • No liquid releases. | • The annual dose to the maximally exposed member of the public from total site operation would be 14 mrem from liquid releases for each technology, and the associated risk of fatal cancer from 40 years of operation would be $2.7 \times 10^{-4}$ for all technologies, except for the ALWRs ($2.8 \times 10^{-4}$). | • No liquid releases. | • The annual dose to a maximally exposed member of the public from total site operation from liquid releases, and associated (risk of fatal cancer) from 40 years of operation by technology:<br>HWR: 0.16 mrem ($3.3 \times 10^{-6}$)<br>MHTGR: 0.077 mrem ($1.5 \times 10^{-6}$)<br>Large ALWR: 0.16 mrem ($3.3 \times 10^{-6}$)<br>Small ALWR: 0.26 mrem ($5.3 \times 10^{-6}$)<br>APT (for either target system): 0.077 mrem ($1.5 \times 10^{-6}$) |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 11 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The 50-mile population dose (person-rem) from total site operations in 2030 and (number of fatal cancers) from 40 years of operation and by technology:<br>HWR: 53 person-rem (1.1)<br>MHTGR: 37 person-rem (0.73)<br>Large ALWR: 73 person-rem (1.5)<br>Small ALWR: 71 person-rem (1.4)<br>APT (He-3): 23 person-rem (0.45)<br>APT (SILC): 32 person-rem (0.64) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (number of fatal cancers) from 40 years of operation and by technology:<br>HWR: 0.20 person-rem ($4.0x10^{-3}$)<br>MHTGR: 0.13 person-rem($2.6x10^{-3}$)<br>Large ALWR: 0.24 person-rem ($4.9 x10^{-3}$)<br>Small ALWR: 0.25 person-rem ($5.1x10^{-3}$)<br>APT (He-3): 0.08 person-rem($1.6x10^{-3}$)<br>APT (SILC): 0.10 person-rem($2.3x10^{-3}$) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (number of fatal cancers) from 40 years of operation and by technology:<br>HWR: 82 person-rem (1.6)<br>MHTGR: 76 person-rem (1.5)<br>Large ALWR: 90 person-rem (1.8)<br>Small ALWR: 87 person-rem (1.7)<br>APT (He-3): 68 person-rem (1.4 )<br>APT (SILC): 73 person-rem (1.5) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (number of fatal cancers) from 40 years of operation and by technology:<br>HWR: 28 person-rem (0.55)<br>MHTGR: 16 person-rem (0.31)<br>Large ALWR: 37 person-rem (0.73)<br>Small ALWR: 35 person-rem (0.69)<br>APT (He-3): 9.2 person-rem (0.18)<br>APT (SILC): 14 person-rem (0.27) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (number of fatal cancers) from 40 years of operation and by technology:<br>HWR: 300 person-rem (6.1)<br>MHTGR: 260 person-rem (5.2)<br>Large ALWR: 340 person-rem (6.8)<br>Small ALWR: 310 person-rem (6.2)<br>APT (He-3): 220 person-rem (4.4)<br>APT (SILC): 250 person-rem (4.9) |
| • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 33 mrem ($5.2x10^{-4}$)<br>MHTGR: 31 mrem ($5.0x10^{-4}$)<br>Large ALWR: 49 mrem ($7.9x10^{-4}$)<br>Small ALWR: 41 mrem ($6.6x10^{-4}$)<br>APT (He-3): 34 mrem ($5.4x10^{-4}$) for either target system<br>APT (SILC): 34 mrem ($5.5x10^{-4}$) | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 34 mrem ($5.4x10^{-4}$)<br>MHTGR: 26 mrem ($4.2x10^{-4}$)<br>Large ALWR: 140 mrem ($2.3x10^{-3}$)<br>Small ALWR: 92 mrem ($1.5x10^{-3}$)<br>APT (He-3): 43 mrem ($6.9x10^{-4}$)<br>APT (SILC): 44 mrem ($7.0x10^{-4}$) | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 19 mrem ($3.0x10^{-4}$)<br>MHTGR: 18 mrem ($2.9x10^{-4}$)<br>Large ALWR: 26 mrem ($4.2x10^{-4}$)<br>Small ALWR: 22 mrem ($3.6x10^{-4}$)<br>APT: 20 mrem ($3.1x10^{-4}$) for either target system | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 25 mrem ($4.0x10^{-4}$)<br>MHTGR: 22 mrem ($3.5x10^{-4}$)<br>Large ALWR: 68 mrem ($1.1x10^{-3}$)<br>Small ALWR: 46 mrem ($7.4x10^{-4}$)<br>APT: 29 mrem ($4.6x10^{-4}$ ) for either target system | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 34 mrem ($5.4x10^{-4}$)<br>MHTGR: 33 mrem ($5.3x10^{-4}$)<br>Large ALWR: 42 mrem ($6.7x10^{-4}$)<br>Small ALWR: 38 mrem ($6.1x10^{-4}$)<br>APT (He-3): 34 mrem ($5.4x10^{-4}$ )<br>APT (SILC): 34 mrem ($5.4x10^{-4}$) |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 12 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The annual dose (person-rem) to the total site workforce and (fatal cancers) from 40 years of operation by technology:<br>HWR: 261 person-rem (4.2)<br>MHTGR: 250 person-rem (4.0)<br>Large ALWR: 392 person-rem (6.3)<br>Small ALWR: 322 person-rem (5.2)<br>APT (He-3): 273 person-rem (4.4)<br>APT (SILC): 274 person-rem (4.4) | • The annual dose (person-rem) to the total site workforce and (fatal cancers) from 40 years of operation by technology:<br>HWR: 44 person-rem (0.70)<br>MHTGR: 33 person-rem (0.53)<br>Large ALWR: 180 person-rem (2.8)<br>Small ALWR: 100 person-rem (1.7)<br>APT (He-3): 56 person-rem (0.90)<br>APT (SILC): 57 person-rem (0.91) | • The annual dose (person-rem) to the total site workforce and (fatal cancers) from 40 years of operation by technology:<br>HWR: 360 person-rem (5.8)<br>MHTGR: 350 person-rem (5.6)<br>Large ALWR: 490 person-rem (7.9)<br>Small ALWR: 420 person-rem (6.7)<br>APT (He-3): 373 person-rem (6.0)<br>APT (SILC): 372 person-rem (6.0) | • The annual dose (person-rem) to the total site workforce and (fatal cancers) from 40 years of operation by technology:<br>HWR: 78 person-rem (1.2)<br>MHTGR: 67 person-rem (1.1)<br>Large ALWR: 210 person-rem (3.3)<br>Small ALWR: 140 person-rem (2.2)<br>APT (He-3): 90 person-rem (1.4)<br>APT (SILC): 91 person-rem (1.5) | • The annual dose (person-rem) to the total site workforce and (fatal cancers) from 40 years of operation by technology:<br>HWR: 520 person-rem (8.3)<br>MHTGR: 510 person-rem (8.2)<br>Large ALWR: 650 person-rem (10)<br>Small ALWR: 580 person-rem (9.3)<br>APT (He-3): 533 person-rem (8.5)<br>APT (SILC): 534 person-rem (8.5) |
| • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. |
| • For chemicals the Hazard Index for the maximally exposed member of the public and site worker by technology:<br><br>Public<br>HWR: $2.1 \times 10^{-4}$<br>MHTGR: $1.8 \times 10^{-4}$<br>Large and Small ALWR: $6.3 \times 10^{-4}$<br>APT: $1.8 \times 10^{-4}$ for either target system<br>Cancer Risk: 0 | • For chemicals the Hazard Index for the maximally exposed member of the public and site worker by technology:<br><br>Public<br>HWR: $6.3 \times 10^{-6}$<br>MHTGR: $2.2 \times 10^{-7}$<br>Large and Small ALWR: $7.7 \times 10^{-5}$<br>APT: $1.8 \times 10^{-7}$ for either target system<br>Cancer Risk: 0 | • For chemicals the Hazard Index for the maximally exposed member of the public and site worker by technology:<br><br>Public<br>HWR: 0.36<br>MHTGR: 0.36<br>Large and Small ALWR: 0.38<br>APT: 0.36 for either target system<br>Cancer Risk: 0 | • For chemicals the Hazard Index for the maximally exposed member of the public and site worker by technology:<br><br>Public<br>HWR: 0.031<br>MHTGR: 0.030<br>Large and Small ALWR: 0.036<br>APT: 0.030 for either target system<br>Cancer Risk: $1.1 \times 10^{-5}$ | • For chemicals the Hazard Index for the maximally exposed member of the public and site worker by technology:<br><br>Public<br>HWR: 0.7<br>MHTGR: 0.7<br>Large and Small ALWR: 0.7<br>APT: 0.7 for either target system<br>Cancer Risk: $3.2 \times 10^{-5}$ |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 13 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| Worker<br>HWR: 0.031<br>MHTGR: 0.021<br>Large and Small ALWR: 0.13<br>APT: 0.021 for either target system<br>Cancer Risk: 0 | Worker<br>HWR: $3.2 \times 10^{-3}$<br>MHTGR: $3.4 \times 10^{-5}$<br>Large and Small ALWR: 0.038<br>APT: $3.4 \times 10^{-5}$ for either target system<br>Cancer Risk: 0 | Worker<br>HWR: 0.27<br>MHTGR: 0.32<br>Large and Small ALWR: 0.35<br>APT: 0.26 for either target system<br>Cancer Risk: 0 | Worker<br>HWR: 0.49<br>MHTGR: 0.49<br>Large and Small ALWR: 0.49<br>APT: 0.49 for either target system<br>Cancer Risk: 0.01 | Worker<br>HWR: 1.8<br>MHTGR: 1.8<br>Large and Small ALWR: *1.9<br>APT: 1.8 for either target system<br>Cancer Risk: $5.9 \times 10^{-3}$<br>*Cancer Risk: $5.9 \times 10^{-3}$ |
| All values are within regulatory limits. | All values are within regulatory limits. | All values are within regulatory limits. | The Hazard Index values are within regulatory limits, but the cancer risks to both the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. | The Hazard Index value for the public is within regulatory limits, however the Hazard Index value to the worker exceeds the action level of 1.0 based on OSHA's exposure limits. Cancer risks to the public and site workers both exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$. |
| | | **Tritium Supply Alone** | | |
| • The annual dose (mrem) to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology: | • The annual dose (mrem) to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology: | • The annual dose (mrem) to the maximally exposed member of the public from airborne releases from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology: | • The annual dose (mrem) to the maximally exposed member of the public from total site operations and the associated (risk of fatal cancer) from 40 years of operation by technology: | • No tritium supply alone. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 14 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| HWR: 0.18 mrem ($3.7x10^{-6}$)<br>MHTGR: 0.08 mrem ($1.6x10^{-6}$)<br>Large and Small ALWR: 0.25 mrem ($5.1x10^{-6}$) | HWR: 0.19 mrem ($3.8 x 10^{-6}$)<br>MHTGR: 0.09 mrem ($1.7x10^{-6}$)<br>Large and Small ALWR: 0.28 mrem ($5.6x10^{-6}$) | HWR: 4.3 mrem ($8.4x10^{-5}$)<br>MHTGR: 2.9 mrem ($5.4x10^{-5}$)<br>Large ALWR: 6.0 mrem ($1.2x10^{-4}$)<br>Small ALWR: 4.8 mrem ($9.4x10^{-5}$) | HWR: 2.4 mrem ($4.8x10^{-5}$)<br>MHTGR: 1.0 mrem ($2.0x10^{-5}$)<br>Large ALWR: 3.5 mrem ($7.0x10^{-5}$)<br>Small ALWR: 3.4 mrem ($6.8x10^{-5}$) | |
| APT (He-3): 0.0048 mrem ($1.0x10^{-7}$)<br>APT (SILC): 0.05 mrem ($1.1x10^{-6}$) | APT (He-3): 0.01 mrem ($2.0x10^{-7}$)<br>APT (SILC): 0.06 mrem ($1.2x10^{-6}$) | APT (He-3): 1.5 mrem ($3.0x10^{-5}$)<br>APT (SILC): 2.2 mrem ($4.4x10^{-5}$) | APT (He-3): 0.048 mrem ($1.0x10^{-6}$)<br>APT (SILC): 0.7 mrem ($1.4x10^{-5}$) | |
| • No liquid release. | • No liquid release. | • The annual dose to a maximally exposed member of the public from each technology would be 14 mrem from liquid releases, and the associated risk of fatal cancer from 40 years of operation would be $2.7x10^{-4}$. | • No liquid release. | • No tritium supply alone. |
| • The 50-mile population dose (person-rem) from total site operations in 2030 and (fatal cancers) over 40 years of operation by technology:<br>HWR: 31 (0.66)<br>MHTGR: 15 (0.29)<br>Large ALWR: 51 (1.1)<br>Small ALWR: 49 (0.96)<br>APT (He-3): 1 (0.01)<br>APT (SILC): 10 (0.2) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (fatal cancers) over 40 years of operation by technology:<br>HWR: 0.13 ($2.6x10^{-3}$)<br>MHTGR: 0.06 ($1.2x10^{-3}$)<br>Large ALWR: 0.17 ($3.5x10^{-3}$)<br>Small ALWR: 0.18 ($3.7x10^{-3}$)<br>APT (He-3): 0.01 ($2.0x10^{-4}$)<br>APT (SILC): 0.04 ($9.0x10^{-4}$) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (fatal cancers) over 40 years of operation by technology:<br>HWR: 71 (1.4)<br>MHTGR: 65 (1.3)<br>Large ALWR: 79 (1.6)<br>Small ALWR: 76 (1.5)<br>APT (He-3): 57 (1.2)<br>APT (SILC): 62 (1.3) | • The 50-mile population dose (person-rem) from total site operations in 2030 and (fatal cancers) over 40 years of operation by technology:<br>HWR: 19 (0.37)<br>MHTGR: 7 (0.13)<br>Large ALWR: 28 (0.55)<br>Small ALWR: 26 (0.51)<br>APT (He-3): 0.2 ($3.9 x 10^{-3}$)<br>APT (SILC): 5 (0.09) | • No tritium supply alone. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 15 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 34 ($5.4x10^{-4}$)<br>MHTGR: 33 ($5.3x10^{-4}$)<br>Large ALWR: 52 ($8.3x10^{-4}$)<br>Small ALWR: 43 ($6.9x10^{-4}$)<br>APT (He-3): 36 ($5.7x10^{-4}$)<br>APT (SILC): 36 ($5.8x10^{-4}$) | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 47 ($7.5x10^{-4}$)<br>MHTGR: 37 ($6.0x10^{-4}$)<br>Large ALWR: 220 ($3.5x10^{-3}$)<br>Small ALWR: 130 ($2.2x10^{-3}$)<br>APT (He-3): 60 ($9.7x10^{-4}$)<br>APT (SILC): 62 ($9.9x10^{-4}$) | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 19 ($3.0x10^{-4}$)<br>MHTGR: 19 ($3.0x10^{-4}$)<br>Large ALWR: 26 ($4.3x10^{-4}$)<br>Small ALWR: 23 ($3.7x10^{-4}$)<br>APT: 20 ($3.1x10^{-4}$) for either target system | • The average annual dose (mrem) to a site worker and (fatal cancer risk) from 40 years of operation that are associated with total site performance, including the following technology:<br>HWR: 28 ($4.5x10^{-4}$)<br>MHTGR: 24 ($3.9x10^{-4}$)<br>Large ALWR: 78 ($1.3x10^{-3}$)<br>Small ALWR: 53 ($8.6x10^{-4}$)<br>APT (He-3): 32 ($5.1x10^{-4}$)<br>APT (SILC): 33 ($5.2x10^{-4}$) | • No tritium supply alone. |
| • The annual dose (person-rem) to the total site workforce and (fatal cancers) over 40 years of operation by technology:<br>HWR: 260 (4.2)<br>MHTGR: 250 (4.0)<br>Large ALWR: 390 (6.3)<br>Small ALWR: 320 (5.2)<br>APT: 270 (4.4) for either target system | • The annual dose (person-rem) to the total site workforce and (fatal cancers) over 40 years of operation by technology:<br>HWR: 42 (0.67)<br>MHTGR: 31 (0.50)<br>Large ALWR: 180 (2.8)<br>Small ALWR: 98 (1.7)<br>APT (He-3): 54 (0.87)<br>APT (SILC): 55 (0.88) | • The annual dose (person-rem) to the total site workforce and (fatal cancers) over 40 years of operation by technology:<br>HWR: 360 (5.8)<br>MHTGR: 350 (5.6)<br>Large ALWR: 490 (7.9)<br>Small ALWR: 420 (6.7)<br>APT: 370 (6.0) for either target system | • The annual dose (person-rem) to the total site workforce and (fatal cancers) over 40 years of operation by technology:<br>HWR: 76 (1.2)<br>MHTGR: 65 (1.1)<br>Large ALWR: 210 (3.3)<br>Small ALWR: 140 (2.2)<br>APT (He-3): 88 (1.4)<br>APT (SILC): 89 (1.5) | • No tritium supply alone. |
| • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • All radiological doses to the public and site workers are within regulatory limits. | • No tritium supply alone. |
| • For collocation, relative percent reductions of the Hazard Index to the maximally exposed member of the public and site worker by technology: | • For collocation, relative percent reductions of the Hazard Index to the maximally exposed member of the public and site worker by technology: | • For collocation, relative percent reductions of the Hazard Index to the maximally exposed member of the public and site worker by technology: | • For collocation, relative percent reductions of the Hazard Index to the maximally exposed member of the public and site worker by technology: | • No tritium supply alone. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 16 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| Public<br>HWR: 0.3<br>MHTGR: 0.03<br>ALWR: 0.01<br>APT: 0.03<br>Cancer Risk: 0 | Public<br>HWR: 1.4<br>MHTGR: 41<br>ALWR: 0.1<br>APT: 51<br>Cancer Risk: 0 | Public<br>HWR: 0.01<br>MHTGR: 0.01<br>ALWR: 0.01<br>APT: 0.01<br>Cancer Risk: 0 | Public<br>HWR: 10.3<br>MHTGR: 10.6<br>ALWR: 9.3<br>APT: 10.6<br>Cancer Risk: $1.1 \times 10^{-5}$ | |
| Worker<br>HWR: 0.02<br>MHTGR: 0.2<br>ALWR: 0.04<br>APT: 0.2<br>Cancer Risk: 0 | Worker<br>HWR: 0.5<br>MHTGR: 50<br>ALWR: 0.04<br>APT: 50<br>Cancer Risk: 0 | Worker<br>HWR: 0.02<br>MHTGR: 0.01<br>ALWR: 0.01<br>APT: 0.02<br>Cancer Risk: 0 | Worker<br>HWR: 0.003<br>MHTGR: 0.003<br>ALWR: 0.003<br>APT: 0.003<br>Cancer Risk: 0.01 | |
| All values are within regulatory limits. | All values are within regulatory limits. | All values are within regulatory limits. | The HI values are within regulatory health limits, the cancer risks to the public and site worker exceed the typical threshold of regulatory concern of $1.0 \times 10^{-6}$: | |
| • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/high probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting increase in likelihood of cancer fatality, and the cancer risk, for low to moderate consequence/ high probability accidents by technology: |
| Dose (rems)<br>HWR: 0.020<br>MHTGR: 0.022<br>Large ALWR: 5.1<br>Small ALWR: 0.23<br>APT: negligible | Dose (rems)<br>HWR: $8.4 \times 10^{-3}$<br>MHTGR: $9.1 \times 10^{-3}$<br>Large ALWR: 2.3<br>Small ALWR: 0.098<br>APT: negligible | Dose (rems)<br>HWR: 0.14<br>MHTGR: 0.18<br>Large ALWR: 44<br>Small ALWR: 1.9<br>APT: negligible | Dose (rems)<br>HWR: 0.015<br>MHTGR: 0.016<br>Large ALWR: 3.9<br>Small ALWR: 0.18<br>APT: negligible | Dose (rems)<br>HWR: 0.046<br>MHTGR: 0.059<br>Large ALWR: 14<br>Small ALWR: 0.64<br>APT: negligible |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 17 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • Cancer Risk (per year)<br>HWR: $9.9 \times 10^{-8}$<br>MHTGR: $1.1 \times 10^{-7}$<br>Large ALWR: $2.5 \times 10^{-6}$<br>Small ALWR: $1.1 \times 10^{-7}$<br>APT: negligible | • Cancer Risk (per year)<br>HWR: $4.2 \times 10^{-8}$<br>MHTGR: $4.6 \times 10^{-8}$<br>Large ALWR: $1.1 \times 10^{-6}$<br>Small ALWR: $4.9 \times 10^{-8}$<br>APT: negligible | • Cancer Risk (per year)<br>HWR: $6.8 \times 10^{-7}$<br>MHTGR: $9.2 \times 10^{-7}$<br>Large ALWR: $4.4 \times 10^{-5}$<br>Small ALWR: $9.7 \times 10^{-7}$<br>APT: negligible | • Cancer Risk (per year)<br>HWR: $7.4 \times 10^{-8}$<br>MHTGR: $8.1 \times 10^{-8}$<br>Large ALWR: $2.0 \times 10^{-6}$<br>Small ALWR: $8.9 \times 10^{-8}$<br>APT: negligible | • Cancer Risk (per year)<br>HWR: $2.3 \times 10^{-7}$<br>MHTGR: $3.0 \times 10^{-7}$<br>Large ALWR: $7.1 \times 10^{-6}$<br>Small ALWR: $3.2 \times 10^{-7}$<br>APT: negligible |
| Cancer Fatality<br>HWR: $9.9 \times 10^{-6}$<br>MHTGR: $1.1 \times 10^{-5}$<br>Large ALWR: $2.5 \times 10^{-3}$<br>Small ALWR: $1.1 \times 10^{-4}$<br>APT: negligible | Cancer Fatality<br>HWR: $4.2 \times 10^{-6}$<br>MHTGR: $4.6 \times 10^{-6}$<br>Large ALWR: $1.1 \times 10^{-3}$<br>Small ALWR: $4.9 \times 10^{-5}$<br>APT: negligible | Cancer Fatality<br>HWR: $6.8 \times 10^{-5}$<br>MHTGR: $9.2 \times 10^{-5}$<br>Large ALWR: $4.4 \times 10^{-2}$<br>Small ALWR: $9.7 \times 10^{-4}$<br>APT: negligible | Cancer Fatality<br>HWR: $7.4 \times 10^{-6}$<br>MHTGR: $8.1 \times 10^{-6}$<br>Large ALWR: $2.0 \times 10^{-3}$<br>Small ALWR: $8.9 \times 10^{-5}$<br>APT: negligible | Cancer Fatality<br>HWR: $2.3 \times 10^{-5}$<br>MHTGR: $3.0 \times 10^{-5}$<br>Large ALWR: $7.1 \times 10^{-3}$<br>Small ALWR: $3.2 \times 10^{-4}$<br>APT: negligible |
| | | **Radiological Impacts from Accidents—Collocated Tritium Supply and Recycling** | | |
| The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: |
| Dose (person-rems)<br>HWR: 180<br>MHTGR: 200<br>Large ALWR: $4.5 \times 10^{4}$<br>Small ALWR: $2.1 \times 10^{3}$<br>APT: negligible | Dose (person-rems)<br>HWR: 3.2<br>MHTGR: 3.4<br>Large ALWR: 830<br>Small ALWR: 37<br>APT: negligible | Dose (person-rems)<br>HWR: $1.6 \times 10^{3}$<br>MHTGR: $2.0 \times 10^{3}$<br>Large ALWR: $4.9 \times 10^{4}$<br>Small ALWR: $2.2 \times 10^{5}$<br>APT: negligible | Dose (person-rems)<br>HWR: 52<br>MHTGR: 68<br>Large ALWR: $1.6 \times 10^{4}$<br>Small ALWR: 730<br>APT: negligible | Dose (rems)<br>HWR: $1.5 \times 10^{3}$<br>MHTGR: $2.0 \times 10^{3}$<br>Large ALWR: $4.6 \times 10^{5}$<br>Small ALWR: $2.1 \times 10^{4}$<br>APT: negligible |
| Cancer Risk<br>HWR: $9.2 \times 10^{-4}$<br>MHGTR: $1.0 \times 10^{-3}$<br>Large ALWR: 0.023<br>Small ALWR: $1.1 \times 10^{-3}$<br>APT: negligible | Cancer Risk<br>HWR: $1.6 \times 10^{-5}$<br>MHTGR: $1.7 \times 10^{-5}$<br>Large ALWR: $4.1 \times 10^{-4}$<br>Small ALWR: $1.8 \times 10^{-5}$<br>APT: negligible | Cancer Risk<br>HWR: $8.0 \times 10^{-3}$<br>MHTGR: 0.01<br>Large ALWR: 0.24<br>Small ALWR: 0.011<br>APT: negligible | Cancer Risk<br>HWR: $2.6 \times 10^{-4}$<br>MHTGR: $3.4 \times 10^{-4}$<br>Large ALWR: $8.0 \times 10^{-3}$<br>Small ALWR: $3.6 \times 10^{-4}$<br>APT: negligible | Cancer Risk (per year)<br>HWR: $7.4 \times 10^{3}$<br>MHTGR: 0.01<br>Large ALWR: 0.23<br>Small ALWR: 0.011<br>APT: negligible |
| Cancer Fatalities<br>HWR: 0.092<br>MHGTR: 0.10<br>Large ALWR: 23<br>Small ALWR: 1.1<br>APT: negligible | Cancer Fatalities<br>HWR: $1.6 \times 10^{-3}$<br>MHTGR: $1.7 \times 10^{-3}$<br>Large ALWR: 0.41<br>Small ALWR: 0.018<br>APT: negligible | Cancer Fatalities<br>HWR: 0.8<br>MHTGR: 1.0<br>Large ALWR: 240<br>Small ALWR: 11<br>APT: negligible | Cancer Fatalities<br>HWR: 0.026<br>MHTGR: 0.034<br>Large ALWR: 8.0<br>Small ALWR: 0.36<br>APT: negligible | Cancer Fatalities<br>HWR: 0.74<br>MHTGR: 1.0<br>Large ALWR: 230<br>Small ALWR: 11<br>APT: negligible |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 18 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents by technology: | • The dose to a maximally exposed individual at the site boundary, the resulting cancer risk and the increase in likelihood of cancer fatality for high consequence/low probability accidents by technology: |
| Dose (rems)<br>HWR: 41.1<br>MHTGR: 0.078<br>Large ALWR: 166<br>Small ALWR: 149<br>APT (He-3): $1.3 \times 10^{-5}$<br>APT(SILC): $1.6 \times 10^{-4}$ | Dose (rems)<br>HWR: 71<br>MHTGR: 0 .14<br>Large ALWR: 284<br>Small ALWR: 266<br>APT (He-3): $2.1 \times 10^{-5}$<br>APT (SILC): $2.4 \times 10^{-4}$ | Dose (rems)<br>HWR: $1.3 \times 10^{3}$<br>MHTGR: 2.5<br>Large ALWR: $5.1 \times 10^{3}$<br>Small ALWR: $5.3 \times 10^{3}$<br>APT (He-3): $3.3 \times 10^{-4}$<br>APT (SILC): $3.3 \times 10^{-3}$ | Dose (rems)<br>HWR: 426<br>MHTGR: 0.82<br>Large ALWR: $1.7 \times 10^{3}$<br>Small ALWR: $1.7 \times 10^{3}$<br>APT (He-3): $1.1 \times 10^{-4}$<br>APT (SILC): $1.1 \times 10^{-3}$ | Dose (rems)<br>HWR: 44.5<br>MHTGR: 0.08<br>Large ALWR: 174<br>Small ALWR: 174<br>APT (He-3): $1.1 \times 10^{-5}$<br>APT (SILC): $1.2 \times 10^{-4}$ |
| Cancer Risk (per year)<br>HWR: $4.9 \times 10^{-11}$<br>MHTGR: $1.1 \times 10^{-13}$<br>Large ALWR: $7.4 \times 10^{-11}$<br>Small ALWR: $8.6 \times 10^{-11}$<br>APT(He-3): $1.8 \times 10^{-14}$<br>APT(SILC): $1.4 \times 10^{-13}$ | Cancer Risk (per year)<br>HWR: $8.9 \times 10^{-11}$<br>MHTGR: $2.0 \times 10^{-13}$<br>Large ALWR: $1.3 \times 10^{-10}$<br>Small ALWR: $1.5 \times 10^{-10}$<br>APT(He-3): $3.4 \times 10^{-14}$<br>APT(SILC): $2.6 \times 10^{-13}$ | Cancer Risk (per year)<br>HWR: $1.8 \times 10^{-9}$<br>MHTGR: $4.1 \times 10^{-12}$<br>Large ALWR: $2.6 \times 10^{-9}$<br>Small ALWR: $3.2 \times 10^{-9}$<br>APT(He-3): $6.9 \times 10^{-13}$<br>APT(SILC): $5.2 \times 10^{-12}$ | Cancer Risk (per year)<br>HWR: $6.0 \times 10^{-10}$<br>MHTGR: $1.3 \times 10^{-12}$<br>Large ALWR: $8.7 \times 10^{-10}$<br>Small ALWR: $1.0 \times 10^{-9}$<br>APT(He-3): $2.3 \times 10^{-13}$<br>APT(SILC): $1.7 \times 10^{-12}$ | Cancer Risk (per year)<br>HWR: $6.1 \times 10^{-11}$<br>MHTGR: $1.4 \times 10^{-13}$<br>Large ALWR: $9.1 \times 10^{-11}$<br>Small ALWR: $1.1 \times 10^{-10}$<br>APT(He-3): $2.3 \times 10^{-14}$<br>APT (SILC): $1.7 \times 10^{-13}$ |
| Cancer Fatality<br>HWR: $9.9 \times 10^{-4}$<br>MHTGR: $1.8 \times 10^{-6}$<br>Large ALWR: $3.7 \times 10^{-3}$<br>Small ALWR: $4.3 \times 10^{-3}$<br>APT(He-3): $1.8 \times 10^{-10}$<br>APT(SILC): $1.4 \times 10^{-9}$ | Cancer Fatality<br>HWR: $1.8 \times 10^{-3}$<br>MHTGR: $3.3 \times 10^{-6}$<br>Large ALWR: $6.7 \times 10^{-3}$<br>Small ALWR: $7.7 \times 10^{-3}$<br>APT(He-3): $3.4 \times 10^{-10}$<br>APT(SILC): $2.6 \times 10^{-9}$ | Cancer Fatality<br>HWR: 0.04<br>MHTGR: $6.8 \times 10^{-5}$<br>Large ALWR: 0.13<br>Small ALWR:0.16<br>APT(He-3): $6.9 \times 10^{-9}$<br>APT(SILC): $5.2 \times 10^{-8}$ | Cancer Fatality<br>HWR: $1.2 \times 10^{-2}$<br>MHTGR: $2.2 \times 10^{-5}$<br>Large ALWR: 0.04<br>Small ALWR: 0.05<br>APT(He-3): $2.3 \times 10^{-9}$<br>APT(SILC): $1.7 \times 10^{-8}$ | Cancer Fatality<br>HWR: $1.2 \times 10^{-3}$<br>MHTGR: $2.3 \times 10^{-6}$<br>Large ALWR: $4.6 \times 10^{-3}$<br>Small ALWR: $5.3 \times 10^{-3}$<br>APT(He-3): $2.3 \times 10^{-10}$<br>APT (SILC): $1.7 \times 10^{-9}$ |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 19 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: | The estimated dose, the annual cancer risk, and the total cancer fatalities for the population residing within 50 miles: |
| Dose (person-rems)<br>HWR: $1.3 \times 10^5$<br>MHTGR: 226<br>Large ALWR: $4.6 \times 10^5$<br>Small ALWR: $5.7 \times 10^5$<br>APT(He-3): 0.018<br>APT(SILC): 0.10 | Dose (person-rems)<br>HWR: $1.3 \times 10^4$<br>MHTGR: 22.7<br>Large ALWR: $4.6 \times 10^4$<br>Small ALWR: $5.7 \times 10^4$<br>APT(He-3): $1.8 \times 10^3$<br>APT (SILC): 0.011 | Dose (person-rems)<br>HWR: $1.0 \times 10^6$<br>MHTGR: $1.9 \times 10^3$<br>Large ALWR: $3.7 \times 10^6$<br>Small ALWR: $4.4 \times 10^6$<br>APT(He-3): 0.18<br>APT (SILC):1.2 | Dose (rems)<br>HWR: $1.3 \times 10^5$<br>MHTGR: 236<br>Large ALWR: $4.8 \times 10^5$<br>Small ALWR: $5.7 \times 10^5$<br>APT(He-3): 0.022<br>APT (SILC): 0.15 | Dose (rems)<br>HWR: $4.4 \times 10^5$<br>MHTGR: 800<br>Large ALWR: $1.6 \times 10^6$<br>Small ALWR: $2.0 \times 10^6$<br>APT(He-3): 0.068<br>APT (SILC): 0.43 |
| Cancer Risk (per year)<br>HWR: $3.2 \times 10^{-6}$<br>MHTGR: $6.8 \times 10^{-9}$<br>Large ALWR: $4.6 \times 10^{-6}$<br>Small ALWR: $5.6 \times 10^{-6}$<br>APT(He-3): $9.0 \times 10^{-10}$<br>APT(SILC): $5.0 \times 10^{-9}$ | Cancer Risk (per year)<br>HWR: $3.2 \times 10^{-7}$<br>MHTGR: $6.8 \times 10^{-10}$<br>Large ALWR: $4.6 \times 10^{-7}$<br>Small ALWR: $5.7 \times 10^{-7}$<br>APT(He-3): $9.0 \times 10^{-11}$<br>APT (SILC): $5.3 \times 10^{-10}$ | Cancer Risk (per year)<br>HWR: $2.5 \times 10^{-5}$<br>MHTGR: $5.5 \times 10^{-8}$<br>Large ALWR: $3.7 \times 10^{-5}$<br>Small ALWR: $4.5 \times 10^{-5}$<br>APT(He-3): $9.0 \times 10^{-9}$<br>APT (SILC): $6.1 \times 10^{-8}$ | Cancer Risk (per year)<br>HWR: $3.2 \times 10^{-6}$<br>MHTGR: $7.1 \times 10^{-9}$<br>Large ALWR: $4.8 \times 10^{-6}$<br>Small ALWR: $5.7 \times 10^{-6}$<br>APT(He-3): $1.1 \times 10^{-9}$<br>APT (SILC): $7.5 \times 10^{-9}$ | Cancer Risk (per year)<br>HWR: $1.1 \times 10^{-5}$<br>MHTGR: $2.4 \times 10^{-8}$<br>Large ALWR: $1.6 \times 10^{-5}$<br>Small ALWR: $2.0 \times 10^{-5}$<br>APT(He-3): $3.4 \times 10^{-9}$<br>APT (SILC): $2.2 \times 10^{-8}$ |
| Cancer Fatalities<br>HWR: 63.3<br>MHTGR: 0.11<br>Large ALWR: 229<br>Small ALWR: 282<br>APT(He-3): $9.0 \times 10^{-6}$<br>APT(SILC): $5.0 \times 10^{-5}$ | Cancer Fatalities<br>HWR: 6.4<br>MHTGR: 0.011<br>Large ALWR: 23<br>Small ALWR: 28.4<br>APT(He-3): $9.0 \times 10^{-7}$<br>APT (SILC): $5.3 \times 10^{-6}$ | Cancer Fatalities<br>HWR: 504<br>MHTGR: 0.92<br>Large ALWR: $1.9 \times 10^3$<br>Small ALWR: $2.2 \times 10^3$<br>APT(He-3): $9.0 \times 10^{-5}$<br>APT(SILC): $6.1 \times 10^{-4}$ | Cancer Fatality<br>HWR: 64.4<br>MHTGR: 0.12<br>Large ALWR: 238<br>Small ALWR: 283<br>APT(He-3): $1.1 \times 10^{-5}$<br>APT (SILC): $7.5 \times 10^{-5}$ | Cancer Fatality<br>HWR: 222<br>MHTGR: 0.40<br>Large ALWR: 808<br>Small ALWR: 984<br>APT(He-3): $3.4 \times 10^{-5}$<br>APT (SILC): $2.2 \times 10^{-4}$ |
| **Tritium Supply Alone** | | | | |
| • The radiological impacts are identical to the collocated supply and recycling. | • The radiological impacts are identical to the collocated supply and recycling. | • The radiological impacts are identical to the collocated supply and recycling. | • The radiological impacts are identical to the collocated supply and recycling. | • No tritium supply alone. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 20 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Waste Management—No Action** | | | | |
| • Under No Action, INEL would continue to manage spent nuclear fuel and the following waste types: high-level, TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. | • Under No Action, NTS would continue to manage the following waste types: TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. | • Under No Action, ORR would continue to manage spent nuclear fuel and the following waste types: TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. | • Under No Action, Pantex would continue to manage the following waste types: low-level, mixed low-level, hazardous, and nonhazardous. | • Under No Action, SRS would continue to manage spent nuclear fuel and the following waste types: high-level, TRU, low-level, mixed TRU and low-level, hazardous, and nonhazardous. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • Spent nuclear fuel would be generated by all technologies, except APT. | • Spent nuclear fuel would be generated by all technologies, except APT. | • Spent nuclear fuel would be generated by all technologies, except APT. | • Spent nuclear fuel would be generated by all technologies, except APT. | • For collocated tritium supply and upgraded recycling facilities, spent nuclear fuel would be generated by all technologies, except APT. |
| New spent nuclear fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change. | New spent nuclear fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change. | New spent nuclear fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change. | New spent nuclear fuel storage facilities would be required. For tritium recycling phaseout at SRS, no change. | New spent nuclear fuel storage facilities would be required. |
| • Liquid LLW would be generated by all technologies except APT, in the following quantities:<br><br>HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY | • Liquid LLW would be generated for all technologies except APT, in the following quantities:<br><br>HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY | • Liquid LLW generation would increase for all technologies except APT. The increase over No Action (587,000 GPY) would be:<br>HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY | • Liquid LLW generation would increase for all technologies except APT. The increase over No Action (400 GPY) would be:<br>HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY | • Liquid LLW would be generated for all technologies except APT, in the following quantities:<br><br>HWR: 2,100,000 GPY<br>MHTGR: 525,000 GPY<br>Large ALWR: 5,000,000 GPY<br>Small ALWR: 790,000 GPY |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 21 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| Existing/planned treatment facility may be adequate for all technologies, except the Large ALWR, which would require a new treatment facility. For tritium recycling phaseout at SRS, no change. | New treatment facilities would be required. For tritium recycling phaseout at SRS, no change. | New treatment facilities would be required. For tritium recycling phaseout at SRS, no change. | New treatment facilities would be required. For tritium recycling phaseout at SRS, no change. | New treatment facilities would be required. |
| • Solid LLW generation would increase and require additional onsite LLW disposal area. | • Solid LLW generation would increase and require additional onsite LLW disposal area. | • Solid LLW generation would increase and require additional onsite LLW disposal area. | • Solid LLW generation would increase and require additional onsite LLW disposal area at NTS. | • Solid LLW generation would increase for all technologies and require additional onsite LLW disposal area. |
| The increase over No Action (5,100 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,550 $yd^3$ per year - 15 acres per year<br>MHTGR: 1,650 $yd^3$ per year - 4 acres per year<br>Large ALWR: 1,060 $yd^3$ per year - 5 acres per year<br>Small ALWR: 1,010 $yd^3$ per year - 3 acres per year<br>APT: 894 $yd^3$ per year - 3 acres per year | The increase over No Action (42,400 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,550 $yd^3$ per year - 13.5 acres per year<br>MHTGR: 1,650 $yd^3$ per year - 4 acres per year<br>Large ALWR: 1,060 $yd^3$ per year - 4.5 acres per year<br>Small ALWR: 1,010 $yd^3$ per year - 2.5 acres per year<br>APT: 894 $yd^3$ per year - 2.5 acres per year | The increase over No Action (9,300 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,550 $yd^3$ per year - 3.5 acres per year<br>MHTGR: 1,650 $yd^3$ per year - 1 acre per year<br>Large ALWR: 1,060 $yd^3$ per year - 1.2 acres per year<br>Small ALWR: 1,010 $yd^3$ per year - 0.7 acres per year<br>APT: 894 $yd^3$ per year - 0.6 acres per year | The increase over No Action (25 $yd^3$ per year) and the additional LLW shipments to NTS would be:<br>HWR: 5,550 $yd^3$ per year - 92 shipments per year<br>MHTGR: 1,650 $yd^3$ per year - 27 shipments per year<br>Large ALWR: 1,060 $yd^3$ per year - 32 shipments per year<br>Small ALWR: 1,010 $yd^3$ per year - 18 shipments per year<br>APT: 894 $yd^3$ per year - 16 shipments per year<br>Additional LLW disposal area at NTS would be the same as in NTS alternatives. | The increase over No Action (5,100 $yd^3$ per year) and the additional LLW disposal area would be:<br>HWR: 5,200 $yd^3$ per year - 12 acres per year<br>MHTGR: 1,300 $yd^3$ per year - 3 acres per year<br>Large ALWR: 710 $yd^3$ per year - 3.5 acres per year<br>Small ALWR: 660 $yd^3$ per year - 2 acres per year<br>APT: 544 $yd^3$ per year - 1 acre per year |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 22 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| For tritium recycling phaseout, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | For tritium recycling phaseout, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | For tritium recycling phaseout, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | For tritium recycling phaseout, 350 $yd^3$ per year decrease in solid LLW at SRS. LLW disposal facility life extended. | No tritium recycling phaseout. |
| • Small quantity (6 GPY) of liquid mixed LLW from recycling facility would be generated. Existing/planned treatment facilities would be adquate. | • Small quantity (6 GPY) of liquid mixed LLW from recycling facility would be generated. Organic mixed waste treatment capability would be required. | • Small quantity (6 GPY) in liquid mixed LLW generation over No Action (470,000 GPY) from recycling facility would be generated. Existing/planned treatment facilities would be adequate. | • Small quantity (6 GPY) in liquid mixed LLW generation over No Action (402 GPY) from recycling facility would be generated. Existing/planned treatment facilities would be adequate. | • No increase in liquid mixed LLW generation from upgraded recycling facility. |
| For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | For tritium recycling phaseout at SRS, 6 GPY of liquid mixed LLW no longer generated at SRS. | No tritium recycling phaseout. |
| • Solid mixed LLW generation would increase. The increase over No Action (655 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year | • Solid mixed LLW generation would increase. The increase over No Action (5,460 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year | • Solid mixed LLW generation would increase. The increase over No Action (11,100 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year | • Solid mixed LLW generation would increase. The increase over No Action (5 $yd^3$ per year) would be:<br>HWR: 122 $yd^3$ per year<br>MHTGR: 3 $yd^3$ per year<br>Large ALWR: 8 $yd^3$ per year<br>Small ALWR: 8 $yd^3$ per year<br>APT: 9 $yd^3$ per year | • Solid mixed LLW generation would increase. The increase over No Action (151 $yd^3$ per year) would be:<br>HWR: 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year |
| HWR may require new or expanded treatment and storage facilities. | Organic mixed waste treatment capability would be required. | Existing/planned treatment facilities would be adequate. | HWR would require new or expanded treatment and storage facilities. | HWR may require new or expanded treatment and storage facilities. Other technologies may require expanded treatment capacity. |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 23 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| For tritium recycling phaseout, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | For tritium recycling phaseout, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | For tritium recycling phaseout, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | For tritium recycling phaseout, 2 $yd^3$ per year decrease in solid mixed LLW at SRS. | No tritium recycling phaseout. |
| • Hazardous waste generation would increase over No Action (308 $yd^3$ per year):<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year<br>APT: 4 $yd^3$ per year | • Hazardous waste generation would increase over No Action (20 $yd^3$ per year):<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year<br>APT: 4 $yd^3$ per year | • Hazardous waste generation would increase over No Action (1,150 $yd^3$ per year):<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year<br>APT: 4 $yd^3$ per year | • Hazardous waste generation would increase over No Action (63 $yd^3$ per year):<br>HWR: 41 $yd^3$ per year<br>MHTGR: 101 $yd^3$ per year<br>Large ALWR: 36 $yd^3$ per year<br>Small ALWR: 36 $yd^3$ per year<br>APT: 4 $yd^3$ per year | • Hazardous waste generation would increase over No Action (13 $yd^3$ per year:<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year |
| Use of existing/planned hazardous waste facilities may be feasible. | Additional hazardous waste storage facilities may be required except for APT. APT may require expansion of existing/planned hazardous waste storage facilities. | Existing/planned hazardous waste facilities would be adequate. | Use of existing/planned hazardous waste facilities would be adequate. | Additional hazardous waste storage facilities may be required except for APT. APT may require expansion of existing/planned hazardous waste storage facilities. |
| For tritium recycling phaseout, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | For tritium recycling phaseout, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | For tritium recycling phaseout, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | For tritium recycling phaseout, 1 $yd^3$ per year decrease in hazardous waste at SRS. Decrease in offsite hazardous waste shipments. | No tritium recycling phaseout. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 24 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Collocated Tritium Supply and Recycling** | | | | |
| • Liquid sanitary waste would be generated:<br>HWR: 2,370 MGY<br>MHTGR: 1,650 MGY<br>Large ALWR: 6,310 MGY<br>Small ALWR: 2,870 MGY<br>APT: 425 MGY<br>New treatment facilities would be required. | • Liquid sanitary waste would be generated:<br>HWR: 2,370 MGY<br>MHTGR: 1,650 MGY<br>Large ALWR: 6,310 MGY<br>Small ALWR: 2,870 MGY<br>APT: 425 MGY<br>New treatment facilities would be required. | • Liquid sanitary waste generation would increase over No Action (484 MGY):<br>HWR: 2,370 MGY<br>MHTGR: 1,650 MGY<br>Large ALWR: 6,310 MGY<br>Small ALWR: 2,870 MGY<br>APT: 425 MGY<br>New treatment facilities would be required. | • Liquid sanitary waste generation would increase over No Action (39.9 MGY):<br>HWR: 62.3 MGY<br>MHTGR: 44.3 MGY<br>Large ALWR: 104 MGY<br>Small ALWR: 64.3 MGY<br>APT: 415 MGY<br>New treatment facilities would be required. | • Liquid sanitary waste generation would increase over No Action (186 MGY):<br>HWR: 2,350 MGY<br>MHTGR: 1,630 MGY<br>Large ALWR: 6,290 MGY<br>Small ALWR: 2,850 MGY<br>APT: 401 MGY<br>New treatment facilities would be required. |
| • For tritium recycling phaseout, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For tritium recycling phaseout, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For tritium recycling phaseout, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • For tritium recycling phaseout, 32 MGY decrease in liquid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. | • No tritium recycling phaseout. |
| • Solid sanitary waste generation would increase over No Action (68,000 $yd^3$ per year):<br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year | • Solid sanitary waste generation would increase over No Action (7,000 $yd^3$ per year):<br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year | • Solid sanitary waste generation would increase over No Action (77,000 $yd^3$ per year):<br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year | • Solid sanitary waste generation would increase over No Action (734 $yd^3$ per year):<br>HWR: 15,000 $yd^3$ per year<br>MHTGR: 14,800 $yd^3$ per year<br>Large ALWR: 14,300 $yd^3$ per year<br>Small ALWR: 11,600 $yd^3$ per year<br>APT: 8,640 $yd^3$ per year | • Solid sanitary waste generation would increase over No Action (80,000 $yd^3$ per year):<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year |
| Onsite landfill design life would be reduced or require expansion. | Onsite landfill design life would be reduced or require expansion. | Onsite landfill design life would be reduced or require expansion. | Offsite (city of Amarillo) landfill design life would be reduced or require expansion. | Onsite landfill design life would be reduced or require expansion. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 25 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | For tritium recycling phaseout at SRS, 7,400 $yd^3$ per year decrease in solid sanitary waste at SRS. Decrease would occur over time as recycling facilities are transitioned. Landfill life would be extended. | No tritium recycling phaseout. |
| For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | For tritium recycling phaseout at SRS, 6,800 $yd^3$ per year decrease in other solid nonhazardous waste at SRS. Decrease in shipments to offsite recyclers. | No tritium recycling phaseout. |
| | | **Tritium Supply Alone** | | |
| • No change to the impacts for spent nuclear fuel. | • No change to the impacts for spent nuclear fuel. | • No change to the impacts for spent nuclear fuel. | • No change to the impacts for spent nuclear fuel. | No tritium recycling phaseout. |
| For tritium recycling upgrade at SRS there would be no change. | For tritium recycling upgrade at SRS there would be no change. | For tritium recycling upgrade at SRS there would be no change. | For tritium recycling upgrade at SRS there would be no change. | |
| • No change to the impacts for liquid LLW. | • No change to the impacts for liquid LLW. | • No change to the impacts for liquid LLW. | • No change to the impacts for liquid LLW. | • No tritium recycling phaseout. |
| For tritium recycling upgrade at SRS there would be no change. | For tritium recycling upgrade at SRS there would be no change. | For tritium recycling upgrade at SRS there would be no change. | For tritium recycling upgrade at SRS there would be no change. | |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 26 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • The increase in solid LLW generation over No Action (5,100 $yd^3$ per year) and the additional oniste LLW disposal area:<br>HWR: 5,200 $yd^3$ per year - 14 acres per year<br>MHTGR: 1,300 $yd^3$ per year - 3 acres per year<br>Large ALWR: 710 $yd^3$ per year - 4 acres per year<br>Small ALWR: 660 $yd^3$ per year -2 acres per year<br>APT: 544 $yd^3$ per year - 2 acres per year<br><br>For tritium recycling upgrade at SRS there would be no change. | • The increase in solid LLW generation over No Action (42,400 $yd^3$ per year) and the additional onsite LLW disposal area:<br>HWR: 5,200 $yd^3$ per year - 12.6 acres per year<br>MHTGR: 1,300 $yd^3$ per year - 3 acres per year<br>Large ALWR: 710 $yd^3$ per year - 3.8 acres per year<br>Small ALWR: 660 $yd^3$ per year -2 acres per year<br>APT: 544 $yd^3$ per year - 1.5 acres per year<br><br>For tritium recycling upgrade at SRS there would be no change. | • The increase in solid LLW generation over No Action (9,300 $yd^3$ per year) and the additional onsite LLW disposal area:<br>HWR: 5,200 $yd^3$ per year - 3.3 acres per year<br>MHTGR: 1,300 $yd^3$ per year - 0.8 acres per year<br>Large ALWR: 710 $yd^3$ per year - 0.7 acres per year<br>Small ALWR: 660 $yd^3$ per year -0.5 acres per year<br>APT: 544 $yd^3$ per year - 0.4 acres per year<br><br>For tritium recycling upgrade at SRS there would be no change. | • The increase in solid LLW generation over No Action (25 $yd^3$ per year) and the additional onsite LLW shipments to NTS:<br>HWR: 5,200 $yd^3$ per year - 86 shipments per year<br>MHTGR: 1,300 $yd^3$ per year -22 shipments per year<br>Large ALWR: 710 $yd^3$ per year - 26 shipments per year<br>Small ALWR: 660 $yd^3$ per year -13 shipments per year<br>APT: 544 $yd^3$ per year - 10 shipments per year<br><br>Additional LLW disposal area at NTS would be the same as in NTS tritium supply alone alternatives. For tritium recycling upgrade at SRS there would be no change. | • No tritium supply alone at SRS. |
| • Liquid mixed LLW would no longer be generated.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Liquid mixed LLW would no longer be generated.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Liquid mixed LLW would no longer be generated.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Liquid mixed LLW would no longer be generated.<br><br>For tritium recycling upgrade at SRS there would be no change. | • No tritium supply alone at SRS. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 27 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • Solid mixed LLW generation would increase over No Action (655 $yd^3$ per year):<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br><br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Solid mixed LLW generation would increase over No Action (5,460 $yd^3$ per year):<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br><br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Solid mixed LLW generation would increase over No Action (11,100 $yd^3$ per year):<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br><br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Solid mixed LLW generation would increase over No Action (5 $yd^3$ per year):<br>HWR : 120 $yd^3$ per year<br>MHTGR: 1 $yd^3$ per year<br>Large ALWR: 6 $yd^3$ per year<br>Small ALWR: 6 $yd^3$ per year<br>APT: 7 $yd^3$ per year<br><br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • No tritium supply alone at SRS. |
| • Hazardous waste generation would increase over No Action (308 $yd^3$ per year):<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br><br>Use of existing/planned hazardous waste facilities may be feasible.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Hazardous waste generation would increase over No Action (20 $yd^3$ per year):<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br><br>Additional hazardous waste storage facilities may be required except for APT. APT may require expansion of existing/planned hazardous waste storage facilities.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Hazardous waste generation would increase over No Action (1,150 $yd^3$ per year):<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br><br>Existing/planned hazardous waste facilities would be adequate.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Hazardous waste generation would increase over No Action (63 $yd^3$ per year):<br>HWR: 40 $yd^3$ per year<br>MHTGR: 100 $yd^3$ per year<br>Large ALWR: 35 $yd^3$ per year<br>Small ALWR: 35 $yd^3$ per year<br>APT: 3 $yd^3$ per year<br><br>Use of existing/planned hazardous waste facilities would be adequate.<br><br>For tritium recycling upgrade at SRS there would be no change. | • No tritium supply alone at SRS. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 28 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| • Liquid sanitary waste generation would increase:<br><br>HWR: 48 MGY<br>MHTGR: 30 MGY<br>Large ALWR: 90 MGY<br>Small ALWR: 50 MGY<br>APT: 401 MGY<br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Liquid sanitary waste generation would increase:<br><br>HWR: 48 MGY<br>MHTGR: 30 MGY<br>Large ALWR: 90 MGY<br>Small ALWR: 50 MGY<br>APT: 401 MGY<br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Liquid sanitary waste generation would increase over No Action (484 MGY):<br>HWR: 2,350 MGY<br>MHTGR: 1,630 MGY<br>Large ALWR: 6,290 MGY<br>Small ALWR: 2,850 MGY<br>APT: 401 MGY<br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Liquid sanitary waste generation would increase over No Action (39.9 MGY):<br>HWR: 48 MGY<br>MHTGR: 30 MGY<br>Large ALWR: 90 MGY<br>Small ALWR: 50 MGY<br>APT: 401 MGY<br>Impacts would remain the same as collocated tritium supply and recycling.<br><br>For tritium recycling upgrade at SRS there would be no change | • No tritium supply alone SRS. |
| • Solid sanitary waste generation would increase over No Action (68,000 $yd^3$ per year):<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br><br>Onsite landfill design life would be reduced or require expansion.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Solid sanitary waste generation would increase over No Action (7,000 $yd^3$ per year):<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br><br>Onsite landfill design life would be reduced or require expansion.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Solid sanitary waste generation would increase over No Action (77,000 $yd^3$ per year):<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br><br>Onsite landfill design life would be reduced or require expansion.<br><br>For tritium recycling upgrade at SRS there would be no change. | • Solid sanitary waste generation would increase over No Action (734 $yd^3$ per year):<br>HWR: 7,600 $yd^3$ per year<br>MHTGR: 7,400 $yd^3$ per year<br>Large ALWR: 6,900 $yd^3$ per year<br>Small ALWR: 4,200 $yd^3$ per year<br>APT: 1,240 $yd^3$ per year<br><br>Offsite (city of Amarillo) landfill design life would be reduced or require expansion.<br><br>For tritium recycling upgrade at SRS there would be no change. | • No tritium supply alone SRS. |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 29 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| **Tritium Supply Alone** | | | | |
| • Other solid nonhazardous waste would be recycled.<br>For tritium recycling upgrade at SRS there would be no change. | • Other solid nonhazardous waste would be recycled.<br>For tritium recycling upgrade at SRS there would be no change. | • Other solid nonhazardous waste would be recycled.<br>For tritium recycling upgrade at SRS there would be no change. | • Other solid nonhazardous waste would be recycled.<br>For tritium recycling upgrade at SRS there would be no change. | • No tritium supply alone at SRS. |
| **Intersite Transport—No Action** | | | | |
| • Under No Action negligible tritium transport. | • Under No Action negligible tritium transport. | • Under No Action negligible tritium transport. | • Under No Action, the cancer fatalities per year of transporting limited-life components under accident conditions to and from SRS would be $1x10^{-8}$ from radiological affects. | • Under No Action the cancer fatalities per year of transporting limited-life components to/from Pantex is negligible under normal operation. Under accident conditions, the cancer fatalities per year of transporting limited-life components to/from Pantex would be $1.0x10^{-8}$ from radiological affects. |
| **Collocated Tritium Supply and Recycling** | | | | |
| • The relative transportation risk of tritium is 29 percent lower than the existing No Action case for all technologies. | • The relative transportation risk of tritium is 30 percent lower than the existing No Action case for all technologies. | • The relative transportation risk of tritium is 13 percent lower than the existing No Action case for all technologies. | • The relative transportation risk of tritium is 0. | • The relative transportation risk of tritium is the same as the existing (No Action) case for all technologies. |
| • The potential cancer fatalities per year for transporting tritiated heavy water are $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water are $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water are $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water are $3.57x10^{-5}$ for the HWR and $6.63x10^{-6}$ for APT. | • There is no intersite transport of tritiated heavy water, therefore no transport cancer fatalities. |

TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 30 of 31]

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Collocated Tritium Supply and Recycling** | | |
| • No intersite transport of low-level waste. | • No intersite transport of low-level waste | • No intersite transport of low-level waste. | • The cancer fatalities per year for credible accidents associated with intersite transport of low-level waste by technology:<br><br>Radiological<br>HWR: $2.99 \times 10^{-8}$<br>MHTGR: $8.79 \times 10^{-9}$<br>Large ALWR: $1.04 \times 10^{-8}$<br>Small ALWR: $5.85 \times 10^{-9}$<br>APT: $5.2 \times 10^{-9}$<br><br>Non-radiological<br>HWR: $3.96 \times 10^{-4}$<br>MHTGR: $1.16 \times 10^{-4}$<br>Large ALWR: $1.38 \times 10^{-4}$<br>Small ALWR: $7.74 \times 10^{-5}$<br>APT: $6.88 \times 10^{-5}$ | • No intersite transport of low-level waste. |
| | | **Tritium Supply Alone** | | |
| • The risk of transporting new tritium is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • The risk of transporting new tritium is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • The risk of transporting new tritium is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • The risk of transporting new tritium is about 2 percent greater than No Action due to transporting virgin tritium to SRS. | • No tritium supply alone. |
| • No intersite transport of LLW. | • No intersite transport of LLW. | • No intersite transport of LLW. | • Credible accidents associated with intersite transport of LLW would result in $3.25 \times 10^{-9}$ to $2.8 \times 10^{-8}$ fatal cancers per year from radiological releases and $4.30 \times 10^{-5}$ to $3.7 \times 10^{-4}$ fatal cancers per year from non-radiological releases. The cancer fatalities per year for each technology would be: | • No tritium supply alone. |

**TABLE ES–1.—*Summary Comparison of Environmental Impacts of Tritium Supply Technologies and Recycling* [Page 31 of 31]**

| INEL | NTS | ORR | PANTEX | SRS |
|---|---|---|---|---|
| | | **Tritium Supply Alone** | | |
| | | | Radiological<br>HWR: $2.8 \times 10^{-8}$<br>MHTGR: $7.15 \times 10^{-9}$<br>Large ALWR: $8.45 \times 10^{-9}$<br>Small ALWR: $4.22 \times 10^{-9}$<br>APT: $3.25 \times 10^{-9}$<br><br>Non-radiological<br>HWR: $3.7 \times 10^{-4}$<br>MHTGR: $9.46 \times 10^{-5}$<br>Large ALWR: $1.12 \times 10^{-4}$<br>Small ALWR: $5.59 \times 10^{-5}$<br>APT: $4.30 \times 10^{-5}$ | |
| • The potential cancer fatalities per year for transporting tritiated heavy water are $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water are $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water are $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • The potential cancer fatalities per year for transporting tritiated heavy water are $1.4 \times 10^{-5}$ for the HWR and $6.63 \times 10^{-6}$ for APT. | • No tritium supply alone. |