NEW MEXICO ENVIRONMENT DEPARTMENT
ENVIRONMENTAL REVIEW COMMENT FORM

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DATE: 1-23-96

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PROJECT TITLE: TRU Waste Drum Staging Building (TA55): DEA

NMED FILE NO.: 96ER SAI NO.: NA

A. Please review the attached document and submit one hard copy of your comments to me no later than 2-5-96; also make sure to mail me an electronic copy through the DO network (User Name: D_P02). Your review should include at least the following:

(1) All requirements or conflicts with NMED laws and regulations of which you know;

(2) All deficiencies or inaccuracies in the information provided which prevent an adequate environmental assessment of the project;

(3) A response to the following question: Do the anticipated accomplishments of the proposal justify the requested funding level? (If "no" please explain in your review);

(4) Other information which may be helpful to understand the environmental impact of the project (e.g., other environmental problems in the vicinity; other project impacts; problems which may develop for which no specific NMED law and regulations apply).

B. Unless otherwise noted, please always use the following procedure:

(1) Return all documents after review;

(2) Use the above NMED File No. in reference to this project;

(3) Type all your comments.

G.C.:Revised 7/95

Rec'd 1-7-96 RLO

DOE/EA-0823

Predecisional Draft Environmental Assessment

TRU Waste Drum Staging Building

Technical Area 55

Alamos National Laboratory

Date Prepared: January 18, 1996

Prepared by: Office of Defense Programs
US Department of Energy

With the technical assistance of:
Nuclear Materials Technology Group
Environmental Assessments and Resource Evaluations Group
Los Alamos National Laboratory
Los Alamos, NM 87545

LANL
TA-55/96

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EXECUTIVE SUMMARY

Much of the US Department of Energy's (DOE's) research on plutonium metallurgy and plutonium processing is performed at Los Alamos National Laboratory (LANL), in Los Alamos, New Mexico. LANL's main facility for plutonium research is the Plutonium Facility, also referred to as Technical Area 55 (TA-55). The main laboratory building for plutonium work within the Plutonium Facility (TA-55) is the Plutonium Facility Building 4, or PF-4. This Environmental Assessment (EA) analyzes the potential environmental effects that would be expected to occur if DOE were to stage sealed containers of transuranic (TRU) and TRU mixed waste in a support building at the Plutonium Facility (TA-55) that is adjacent to PF-4. At present, the waste containers are staged in the basement of PF-4.

The proposed project is to convert an existing support structure (Building 185), a prefabricated metal building on a concrete foundation, and operate it as a temporary staging facility for sealed containers of solid TRU and TRU mixed waste. The TRU and TRU mixed wastes would be contained in sealed 55-gallon drums and standard waste boxes as they await approval to be transported to TA-54. The containers would then be transported to a longer term TRU waste storage area at TA-54. The TRU wastes are generated from plutonium operations carried out in PF-4. The drum staging building would also be used to store and prepare for use new, empty TRU waste containers.

Alternatives addressed in this document include the proposed action; constructing and operating a new TRU waste staging building at TA-55; moving excess containers to the uncovered storage pad at TA-55 and covering the containers; operating in another building at LANL; and the no-action alternative. The no-action alternative is to continue to stage containers in the basement of PF-4; it was analyzed as a baseline for comparison.

Under normal operating circumstances, potentially affected resources include land use for rubble disposal resulting from minor changes needed at Building 185 to accommodate the proposed action. Under accident conditions, worker health and working conditions could be affected. Air quality, water quality, radioactive waste management, waste transportation, and land use per new construction would not be affected by this action. Less than three tons of uncontaminated construction and demolition debris would be generated by converting the existing building for use as a staging facility for containers of TRU waste. Worker exposure is expected to remain the same or decrease slightly from the use of this facility, and working conditions both in the TRU waste container staging area and in the basement of PF-4 would be improved. The accident scenario for the proposed action results in potential effects that are identical with those of the no-action alternative.

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TRU WASTE DRUM STAGING BUILDING
at the Plutonium Facility, TA-55
Los Alamos National Laboratory
Los Alamos, New Mexico

1.0 PURPOSE AND NEED

1.1 BACKGROUND

Much of the Department of Energy's (DOE's[1]) research on plutonium metallurgy and plutonium processing is performed at Los Alamos National Laboratory (LANL), located in Los Alamos, New Mexico. LANL's main facility for plutonium research is the Plutonium Facility, also called Technical Area-55 (TA-55). The main laboratory building for plutonium work within TA-55 is the Plutonium Facility Building 4 (PF-4). There are other buildings within the TA-55 area and security fence, such as Building 185, which is a metal support building adjacent to PF-4. Figures 1, 2, and 3 show the location of LANL, LANL TAs (including TA-55), and buildings within TA-55, respectively. Every year, plutonium processing and research work performed at PF-4 generates up to 100 cubic meters (m) (3700 cubic feet [ft]) of radioactive transuranic (TRU) waste and TRU mixed waste[2]. This is equivalent to about 500 55-gallon drums. TRU wastes from PF-4 consist of solid (in physical form) materials including laboratory equipment, glass, gloves, wipes, etc. contaminated with TRU radioisotopes.

TRU radioisotopes are defined as those which emit alpha particles, have an atomic number (number of protons) greater than 92, and half-lives greater than 20 years. The most frequent TRU components at LANL are plutonium and americium. TRU wastes have TRU contaminants present in excess of 100 nanocuries per gram (ηCi/g) of waste. TRU mixed waste is TRU waste that is also contaminated with material classified as hazardous under the Resource Conservation and Recovery Act (RCRA). DOE plans to dispose of all its TRU and TRU mixed waste at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, at some future time. All waste packages to be disposed of at WIPP must meet the WIPP waste acceptance criteria, also called WIPP WAC (DOE 1991b). TRU mixed wastes must also be managed in compliance with RCRA regulations. LANL has long-term storage capability for such wastes at TA-54.

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[1] Technical terms, abbreviations, and acronyms are identified in Section 8.0 Glossary.

[2] In this document, unless otherwise specified, the term *TRU waste* includes TRU mixed waste. TRU mixed wastes are solid wastes within the RCRA regulatory definition of the term *solid.*

Figure 1. Location of Los Alamos National Laboratory

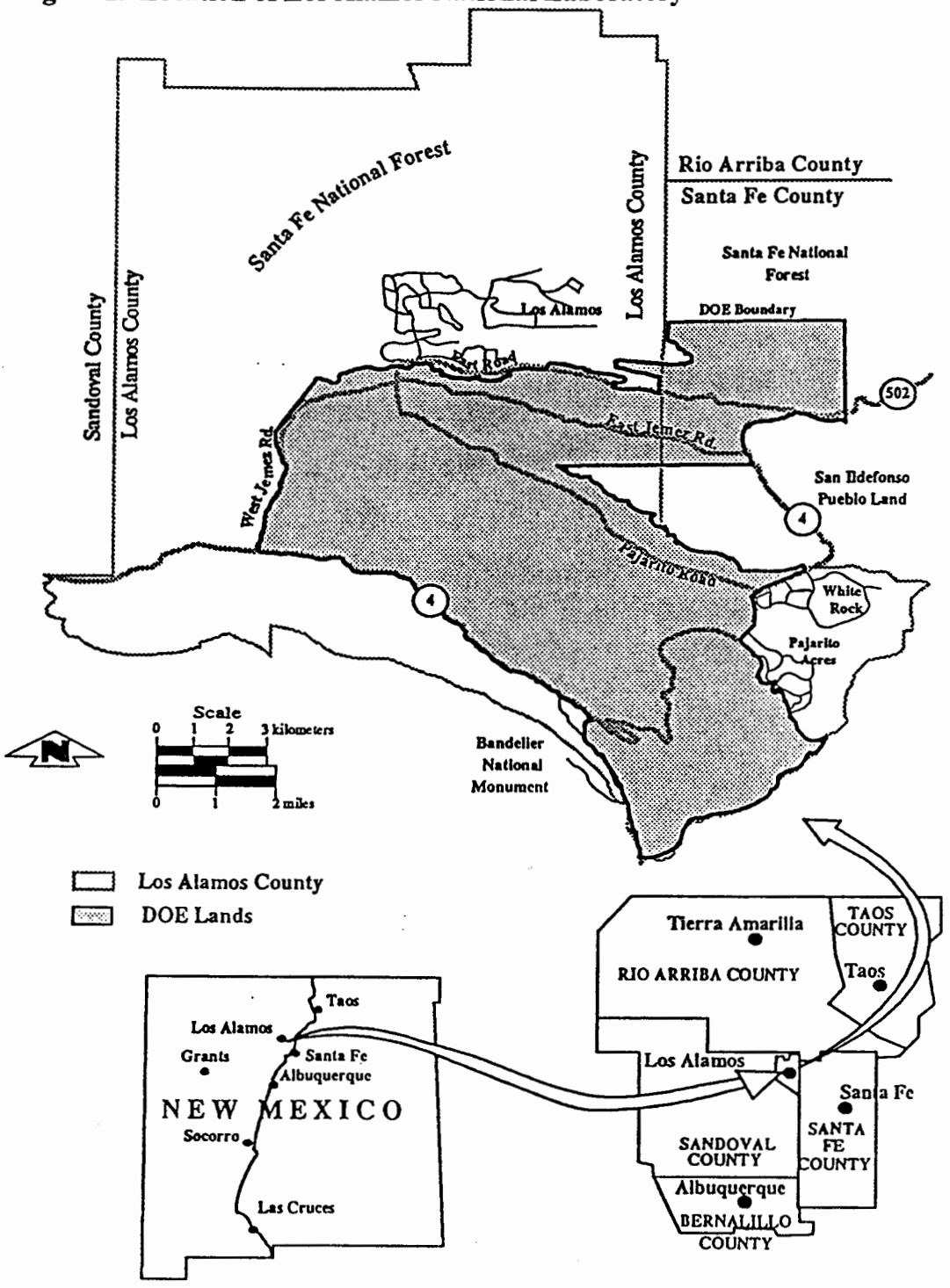


Figure 2. Los Alamos National Laboratory Technical Areas

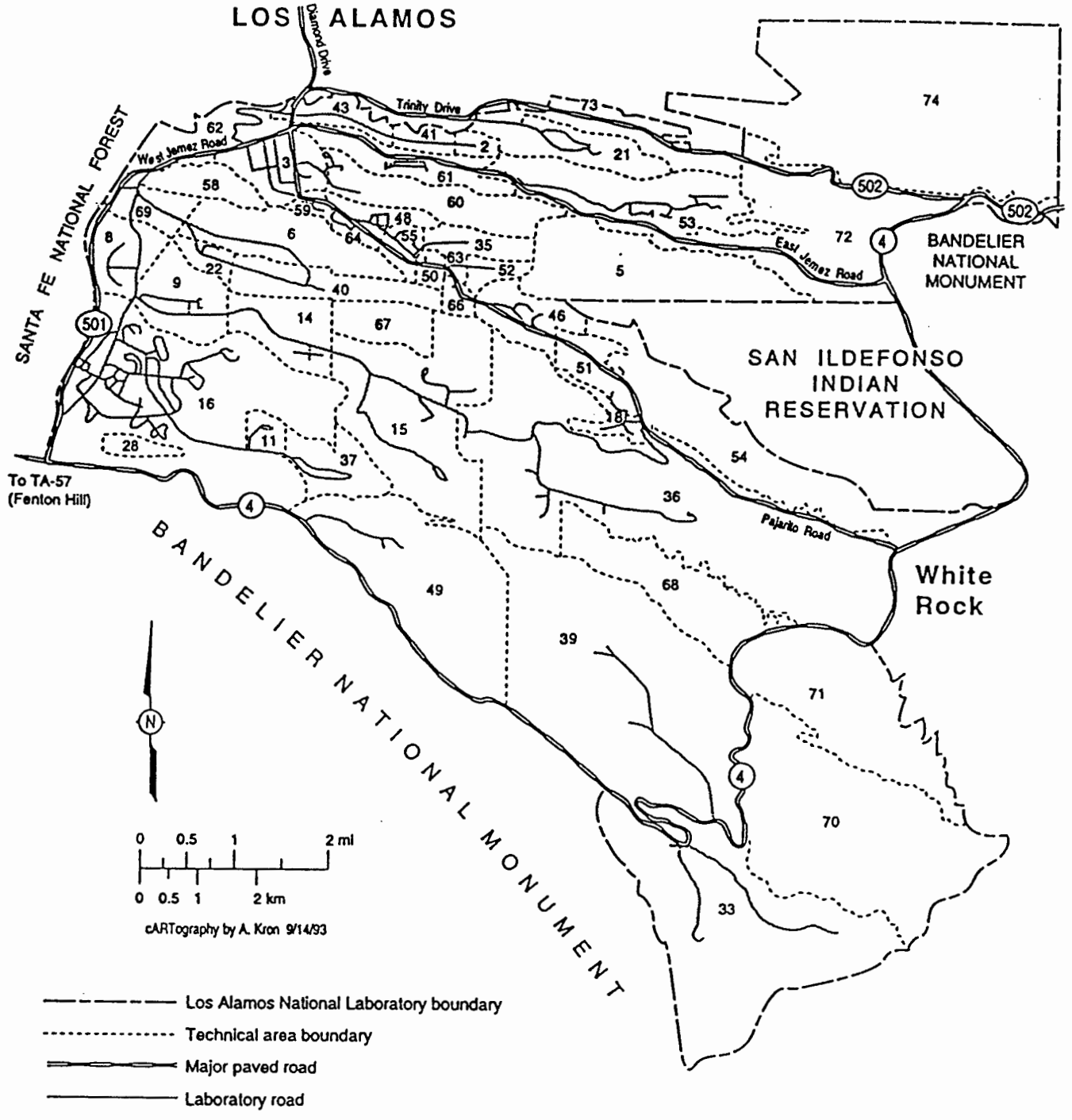
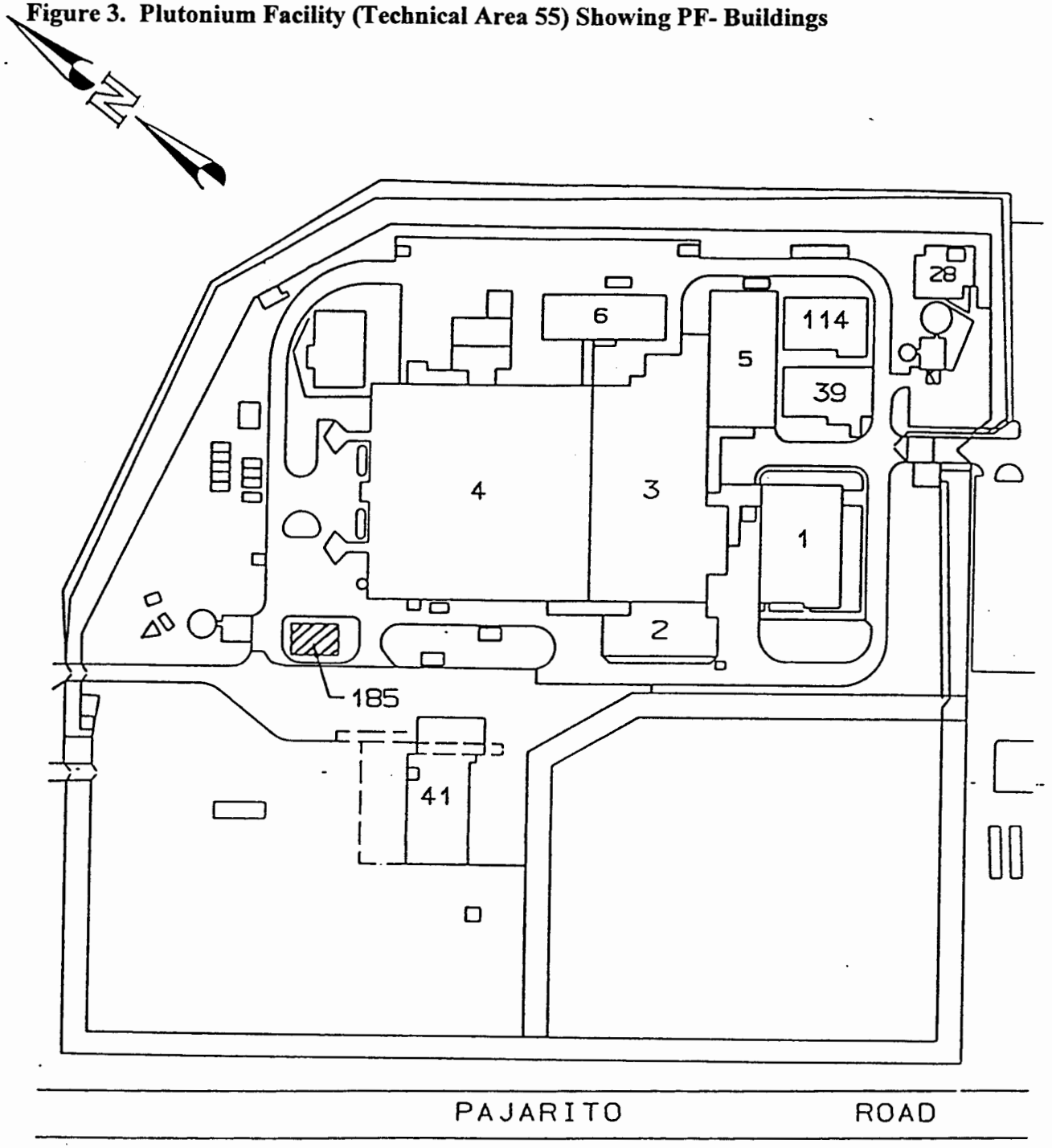


Figure 3. Plutonium Facility (Technical Area 55) Showing PF- Buildings



As a consequence of radioactive decay, TRU waste may emit alpha and beta particles, gamma rays, and neutrons. Gamma rays and neutrons can penetrate the container walls, whereas alpha and beta particles do not because they lack sufficient energy. Gamma rays and neutrons that penetrate the container walls can expose nearby individuals to direct penetrating radiation. The WIPP waste acceptance criteria require that the waste inside the containers must be solid in physical form and that each container must have a vent equipped with a high-efficiency particulate air (HEPA) filter that prevents particulate material, including alpha and beta particles, from escaping and prevents pressure building up in the container (DOE 1991b). No radioactive particulate materials are released to the atmosphere from intact containers of TRU waste, so nearby individuals are not exposed to radioactive particles. However, if rainwater collects on a container surface where the HEPA filter is located, pressure fluctuations due to cycles in air temperature could cause water intrusion through the filter and into the container. WIPP waste acceptance criteria impose very strict limits on allowable free liquid in containers. Thus, any container into which water has intruded may have to be replaced. Workers who repack material into new containers could be exposed to radiation.

In this document, "holding" waste containers (i.e., drums and metal waste boxes) means that the containers are receiving waste, being sealed, and the necessary WIPP certifications are being initiated. "Staging" waste containers means the sealed containers are accumulated and monitored for surface contamination and the certificates required for shipment are completed. Once the staging phase of the process is finished, the containers are transferred to the TA-54 TRU waste storage area where they are then "stored" pending transfer to WIPP.

The PF-4 Building was constructed in the early to mid 1970's before current waste management practices involving WIPP waste certification of TRU wastes were initiated. The waste management practices of that time allowed filled, sealed waste containers to be monitored and removed from the building directly to LANL's TA-54 waste management area without protracted holding or staging of the drums. The basement of PF-4 was originally intended for general facility support use. Areas in the basement have since been reserved to serve as TRU waste holding areas while WIPP waste certification process is conducted. The time that TRU waste containers may remain in the basement holding area is generally about two months, but may extend from several months upwards to one year. Waste containers are filled with waste and sealed in the process areas of PF-4 before being brought to the basement holding area; also certain waste containers may receive wastes and be sealed in place within the holding area itself. After being monitored for residual surface contamination, sealed TRU waste containers may be staged while awaiting the completion of the WIPP waste certification process. Currently approved practices for staging containers of TRU wastes include the use of an

uncovered asphalt staging area adjacent to PF-4. However, since each container is fitted with an individual HEPA filter on the top surface of the container, staging the drums out of doors increases the likelihood of water intrusion. Therefore, it is preferable to continue to hold these drums in the PF-4 basement holding area where they are protected from the weather. The current practice is to continue to hold drums that could actually be staged within the basement holding area and ship them to TA-54 directly from the basement airlock area. When sealed waste containers are accumulated and the WIPP waste certification process is completed, the waste containers are brought to the airlock shipping area to be moved away from PF-4. Only one truck load of waste containers can be shipped at a time.

Although minimum regulatory requirements for holding containers in the basement holding area are currently being met, the situation is less than optimal. About 100 drums can be held within the available floor space of 83 square meters (900 square feet) without reducing aisle space to the minimum specified in the TA-55 RCRA Part B permit minimum of 66 cm (26 in.). Drums and containers held in excess of that number can be accommodated by crowding them and thereby reducing the aisle space to the minimum and/or by stacking them atop the drums already in place. Holding additional containers in this fashion makes it difficult to comply with RCRA mixed waste storage requirements, such as daily visual container inspections. Efficiency of waste container inspection and handling are also compromised by such crowded conditions and it becomes difficult to reach instruments located in the area of the basement. Since the basement and airlock are used for other non-waste purposes, non-involved workers and involved workers alike are exposed to very low levels of penetrating radiation from the TRU waste-filled drums. This radiation exposure increases with time spent in their proximity and with nearness to the drum surfaces. Increases in the number of drums to the maximum amounts that can be held in the basement area also slightly increases this low level exposure. Therefore, the less time involved workers spend in the drum area handling and inspecting waste containers (i.e., the more efficient they are at performing their work), the better; the less time non-involved workers spend in the area passing by to other locations, the better. Additionally, crowding containers into the basement holding area could potentially hamper employee movement from the area in case of an accident or emergency.

1.2 PURPOSE AND NEED FOR AGENCY ACTION

DOE is responsible for managing the wastes generated at LANL, including TRU and TRU mixed wastes, in an environmentally acceptable manner and in compliance with local, state and federal regulations. To accomplish these requirements, the DOE must employ best management practices while keeping potential radiological exposure to workers and the public as low as reasonably achievable (ALARA).

Current TRU and TRU mixed waste management practices at PF-4 result in the following problems:

- The allotted basement holding space is usually crowded with drums being held there. These could be staged on the out of doors staging pad, but this practice is not consistent with industry best management practices due to the possibility of water from rain or snow intruding into the containers.

- When more than 100 drums are crowded into the holding area, drum inspections become difficult to accomplish, and are accomplished in an inefficient manner.

- Crowded floor conditions contribute to poor mobility of personnel in the holding area and poor access to instrumentation.

- Holding and staging the maximum number of TRU waste drums and containers in the available basement contribute to slightly higher radiation exposures to involved workers and also non-involved workers.

- Crowded conditions in the basement holding area could hamper employee movement in the case of an accident or emergency.

To address these problems, the DOE needs to alleviate the crowded TRU waste holding conditions at PF-4 and provide adequate staging room for all the TRU waste containers generated by that facility in a manner that precludes the intrusion of water into the containers.

1.3 ENVIRONMENTAL ASSESSMENT METHODOLOGY

This Environmental Assessment (EA) has been prepared in compliance with the National Environmental Policy Act (NEPA), 42 U.S.C.A. 4321-4370d and the applicable regulations promulgated pursuant to that authority, specifically, 40 CFR 1500-1508, Council on Environmental Quality, and 10 CFR 1021, DOE's regulatory mandate for implementing NEPA. The purpose of the EA is to provide the DOE with sufficient information to determine whether a Finding of No Significant Impact (FONSI) is supported for the proposed action or whether an Environmental Impact Statement (EIS) must be prepared. The assessment of impacts presented herein is based on conservative assumptions that maximize estimates of radiological releases and human exposures.

2.0 DESCRIPTION OF ALTERNATIVES

To meet its need for action, the DOE considered alternatives that included using an existing building adjacent to PF-4 as a staging area for excess drums (the proposed action), constructing a new staging building, moving waste containers to the uncovered storage pad and covering the containers with some impervious material, using another building somewhere else on the LANL site, and continuing to hold the excess drums in the basement of PF-4 (the no-action alternative).

2.1 DESCRIPTION OF PROPOSED ACTION

2.1.1 Summary

The proposed action is to modify the interior of Building 185, located next to PF-4, within the security fence at TA-55, and to use it as an interim (up to one year) staging building for excess, sealed containers of TRU waste. Building 185 is currently used to store non-contaminated miscellaneous items such as excess furniture. The metal building is constructed in such a manner that it could be easily adapted for use as a staging location for containers of TRU waste generated in PF-4. About 100 drums, those that are not ready for staging, could still be held in the basement of PF-4 and excess sealed containers would be moved to the new staging building. This new TRU Drum Staging Building would be approved by the New Mexico Environment Department (NMED) as a permitted storage location for solid mixed TRU waste in compliance with RCRA regulations. Waste containers would be staged in Building 185 as they await approval for transport to a longer term storage area at TA-54. Space in the basement of PF-4 would continue to be used for TRU waste container holding but that use would be limited to single-level accumulation (i.e., drums would not be stacked). The waste containers would be 55-gallon drums and metal waste boxes. Building 185 would also be used to store and prepare empty containers for use. No other existing structure or space within the TA-55 security area meets the availability, capacity, safety, and waste management requirements for interim staging of TRU waste containers. Using a building next to PF-4 in this manner would meet TRU waste best management practices by providing a covered staging area, providing adequate room for efficient container handling and inspection, and providing a staging location away from the PF-4 basement working area, thereby probably decreasing radiation exposure to uninvolved workers.

2.1.2 Description of and Modifications to Building 185

Building 185 is a 2,400 square foot (225 square meter) prefabricated metal building located on a concrete pad on the west side of PF-4 at TA-55. This building provides enough floor space to stage a possible maximum of 850 55-gallon drums and waste boxes containing TRU waste. Normally, a total load of about 230 filled and sealed containers would be expected in the building, plus materials to prepare empty containers for use, drum handling equipment, and about 180 empty TRU drums and other containers.

Building 185 is classified as a General-Use Facility (DOE 1993). The building meets DOE criteria for minimizing risks due to natural phenomena such as high wind and earthquake. The building was constructed in accordance with the 1988 Uniform Building Code (UBC) and for wind loads based on ANSI A58.1 (ANSI 1982) for a site-specific 77 miles per hour wind (DOE 1993).

The expected operational life of the building would be approximately 20 years after it was converted to the proposed use.

Implementing the proposed action would not change the current processes in PF-4 that generate TRU wastes or the current quantities of TRU, LLW, radioactive mop water, or sanitary wastes generated. Additionally, it would not change the current number of individuals working directly with the TRU waste containers or those individuals' radiation doses, the current transportation of containers to TA-54, or the current TRU waste storage at TA-54.

Building 185 is currently used to store miscellaneous furniture and equipment. It would be cleaned out and a wire cage located on the east side of the building would be removed. Electricity, to power the lights and the sliding door, is already available. Some 5 cubic m (150 cubic ft, less than 3 tons) of solid construction and demolition debis generated during the renovation process would be disposed of in the Los Alamos County Landfill. Drums and other containers, handling equipment, and supplies to prepare empty containers for use would be moved into the building.

Safety features already installed in the building include the following:

- a smoke detector alarm system, which alarms locally and in the central control room at TA-55;
- a manual fire alarm, which alarms locally and at the Los Alamos County Fire Department;
- emergency battery-powered lighting;

- a telephone; and
- sturdy metal posts protecting the main electrical supply box.

Safety features that would be added to the building include the following:

- a continuous air monitoring system which would alarm locally in the event of a release of radioactivity in the building,
- a portable emergency eye wash/safety shower station, and
- painting on the floor to indicate normal storage areas, required egress corridors, and normal forklift travel routes.

An automatic fire suppression system would not to be included in the modification of Building 185 for staging TRU waste. Several factors provide the basis for this determination. Limited combustible materials would be present in the TRU waste containers, thereby limiting the fuel for potential fires at the facility. Wastes would meet WIPP acceptance criteria (DOE 1991b) which are based on conservative analysis and incorporate a wide margin of safety for preventing potential fires (DOE 1991a, 1991b). No ignition sources or open flames would be present in Building 185. A fire requires three elements: ignition source, fuel, and oxygen. This eliminates ignition source and fuel, leaving the risk of fire extremely small.

Air exhaust filtration equipment (HEPA filter) would not be required for modifying Building 185. Each TRU waste container is equipped with one or more HEPA filters. The TRU waste container itself provides primary containment of contaminants. The waste must meet WIPP acceptance criteria (DOE 1991b) for immobilization of particulate waste materials such as powders and ash. This requirement minimizes the quantity of particulate radioactive material that could be available for dispersion or inhalation in the event that the integrity of a TRU waste package fails.

Finally, procedural controls would prohibit any work being performed in Building 185 that would require HEPA filtration. That is, any work requiring HEPA filtration would be performed in PF-4 where air is exhausted through HEPA filters.

2.1.3 Operations Within Building 185

Containers would be filled with solid radioactive TRU waste, sealed and scanned while in PF-4, just as they are now. The containers of waste would have a maximum radionuclide content of 200 fissile gram equivalents (FGE) of ^{239}Pu per drum, or 1,000 Curies (Ci) of ^{239}Pu equivalent (PE-Ci) per drum, whichever is lower (DOE 1991b).

At present, 10 individuals work with drums of TRU waste, in addition to other duties at PF-4. These individuals' work would be distributed between operations in Building 185 and PF-4 under the proposed action. The number of workers would not change as a result of staging TRU waste containers in Building 185. The work in Building 185 would be intermittent. Drum staging operations in Building 185 would require about 20 person-hours per week, average. These involved workers would be exposed to penetrating radiation of about 5 mrem/hour at a container surface and 0.7 mrem/hour at a distance of 2 m (6 ft).

The forklift operators would be trained and certified in safe operating practices. Sealed containers would be moved within the TRU Drum Staging Building by a worker using a forklift. The forklift would be equipped with a curved drum-handling mechanism designed to increase the safety of the drum moving operations. A wide sliding door on the west side of the building would facilitate moving drums into and out of the building. The waste-filled containers would be kept (staged) in this building as they await the approval necessary to allow their shipment to the longer-term storage facility at TA-54. Containers would be stacked no more than two high, and inspected as required by RCRA regulations. Corridor widths would exceed minimum requirements.

To detect and contain any accidentally released radioactive contamination, Building 185 exits would be equipped with radiation monitors and the floor would be monitored regularly. Sealed containers would be segregated from empty containers. Workers would not be required to wear protective clothing to move or inspect sealed waste containers.

The WIPP waste certification process would continue as it does now. Each step in the certification process can take from one day to two weeks depending on the availability of personnel and equipment (trucks to ship the waste, forklifts to move the waste, etc.). The total time period is generally two months, but can be longer, depending on the waste stream.

LANL Waste Management personnel would load certified containers on trucks and move them to the designated storage area at TA-54, as is the current practice. Containers are moved from TA-55 to TA-54 approximately 24 times a year.

2.1.4 Equipment Modifications and Future Decommissioning of Building 185

The handling and monitoring equipment would be replaced as needed during the useful life of the building. Repairs would also be made to the building as needed.

The ultimate decontamination and decommissioning of the TRU Drum Staging Building would be considered and a separate NEPA analysis would be prepared at such time in the future as the facility is no longer needed. This could be one aspect of PF-4 decontamination and decommissioning.

2.2 FORESEEABLE RELATED AND FUTURE ACTIONS

The Nuclear Materials Storage Facility (PF-41) is to be repaired for storing useable nuclear materials. It will not be used for TRU waste storage. Environmental impacts of that facility were analyzed in an environmental assessment (DOE, 1986) and a FONSI was signed on August 28, 1986.

DOE proposes to recover sealed neutron sources now held by commercial firms, universities, and other federal agencies. Part of this recovery work may be performed in PF-4 and recovered material would be stored in vaults at TA-55. An EA for the Radioactive Source Recovery Project (DOE/EA-1059) has recently been completed and a FONSI was issued on December 21, 1995.

No other building construction or large-scale renovations are approved for the TA-55 area at this time. No other new activities that would affect TA-55 operations and that would require an EA or EIS are approved.

The LANL Site-wide Environmental Impact Statement (SWEIS), currently being prepared, will address cumulative effects for all LANL operations including those that could result from a decision made regarding the subject of this EA. The Notice of Intent to prepare the LANL SWEIS, published in the Federal Register (FR 1995) indicated that the NEPA review for the TRU Waste Drum Staging Building would proceed independent of the SWEIS because of the pressing need to support staging of waste drums generated by ongoing activities. A Record of Decision for the SWEIS is expected in the spring of 1997. Implementing the proposed action would neither influence nor be influenced by the SWEIS analysis or decisions that may result from them.

2.3 ALTERNATIVE ACTIONS

2.3.1 Construct and Operate a New TRU Waste Drum Staging Building at TA-55

Constructing a new TRU waste drum staging building at TA-55 could be done, but would be at a much greater cost and longer delay than the proposed action. New construction as opposed to modifying an existing building would not conform to the Secretary of Energy's Land and Facility Use policy, issued in 1994, directing DOE to manage land and facilities as valuable national resources. New construction would

generate fugitive dust from construction and truck exhaust fumes from transporting building materials, and would consume raw construction materials. Under this alternative, Building 185 would continue to be used as a warehouse, as it is now, and additional land area would be built upon. This alternative was not considered to be a reasonable alternative to meet the DOE's purpose and need and was not considered further in this EA.

2.3.2 Move Excess Containers to the Uncovered Storage Pad at TA-55 and Cover the Containers

Moving excess containers to an outside storage location and covering the containers with impervious material such as plastic sheeting to provide protection from rain and snow was considered. An uncovered storage pad at TA-55 is currently permitted under RCRA as an interim storage location for mixed waste containers. However, condensation of water on the tops of the covered containers could also lead to water intrusion through the HEPA filters and into the containers. Containers would have to be x-rayed for presence of free liquids before certification could be completed and the containers moved to TA-54 for storage, at an increased cost of time and money. If water collects in a container, it would have to be repacked to meet WIPP certification criteria (DOE 1991b). This alternative could increase worker exposure to radioactive waste and would not fully incorporate best management practices. It is not considered to be a reasonable alternative to meet DOE's purpose and need and was not analyzed further in this EA.

2.3.3 Stage TRU Drums in Another Building at LANL

The WIPP waste certification documentation for each TRU waste container must be completed before it can be transported away from TA-55. This effectively limits the staging location to TA-55. No satisfactory existing alternative location at TA-55 was identified, other than Building 185. This alternative would not be in compliance with environmental protection regulations and was not analyzed further in this EA.

2.3.4 No-Action Alternative

The no-action alternative is to continue to accumulate waste containers in the basement of PF-4 and hold them there. All operations at PF-4 would continue as they are performed now, and TRU waste would continue to be certified for WIPP in the current manner. Ten people work with drums of TRU waste in PF-4, in addition to their other duties. A part of their time, an average total of 20 person-hours weekly, is spent on staging TRU drums.

Waste containers would continue to be held in the basement holding area of PF-4 and shipped from the airlock. They would be transported to TA-54 for longer-term storage before being sent to WIPP. Empty TRU waste containers would continue to be stored outside PF-4 and prepared for use in the basement of PF-4. The current inventory of held waste containers and available space requires that when held containers exceed 100 held on the floor, the excess would be stacked and the aisle space would be reduced to the TA-55 RCRA Part B permit and minimum. When the existing holding area is filled, additional waste containers could also be placed on the uncovered storage pad at TA-55, which is currently permitted under RCRA as an interim storage location for mixed waste containers. The likelihood of water intrusion into the containers would be greatly increased and costs of surveying for free liquid in the drums and perhaps repacking would increase the total cost of waste management. Additionally, worker exposure would increase if repacking were necessary.

This alternative does not meet DOE's purpose and need for action. However, it is analyzed in this EA to provide a baseline for comparison with the proposed action.

3.0 AFFECTED ENVIRONMENT

This section presents the condition of the site and ongoing operations at LANL.

3.1 REGIONAL SETTING

The general location of LANL within the county, Northern New Mexico, and the nation is shown in Figure 1.

3.2 CURRENT CONDITIONS

LANL is a DOE facility located on 111 square kilometers (km) (43 square miles [mi]) of land in Los Alamos County in North-Central New Mexico, approximately 100 km (60 mi) north-northwest of the city of Albuquerque. LANL is on the Pajarito Plateau, a series of mesas and canyons, at an elevation of about 2,200 m (7,200 ft) above sea level. Los Alamos has a semiarid, temperate mountain climate with about 45 cm (18 in.) of annual precipitation. The location of LANL is shown in Figure 1. LANL technical areas are shown in Figure 2.

Detailed descriptions of LANL environs, its climatology, meteorology, and hydrology are presented in the SWEIS (DOE 1979) and in annual Environmental Surveillance Reports (see LANL 1995). Relevant information is summarized below.

LANL supports an ongoing environmental surveillance program, as required by DOE Orders (DOE 1981, 1988a). This program includes routine monitoring programs for radiation, radioactive emissions and effluents, and hazardous materials management at LANL.

3.2.1 Environmental Justice and Zone of Impact

Los Alamos County has an estimated population of approximately 18,115 (US Census, 1990, projected to 1995). The principal population centers located within an 80 km (50 mi) radius of LANL are Santa Fe, Española, and the Pojoaque Valley. They have a total approximate population of 214,727 people. LANL employs approximately 12,250 people (DOE 1995), principally living within 80 km (50 mi) of LANL.

Fourteen pueblos and Native American reservations are located within a 80-km (50-mi) radius of LANL. The populations of the four closest pueblos are as follows: the San Ildefonso Pueblo (15 km [8 mi] to the east) has a population of 1,499 people; the Santa Clara Pueblo (37 km [23 mi] to the northeast) has a population of about 3,000

people; the Cochiti Pueblo (34 km [19 mi] to the west) has 1,342 people; and the Jemez Pueblo (43 km [27 mi] to the west) has 1,750 people (Commerce 1991).

Los Alamos County is approximately 14 percent minority (the percentage of non-whites, including Hispanics, defined by the US Census) and has a median family income of $60,798 (1990 US Census, in 1989 dollars). Los Alamos County, which would be most directly affected by the proposed action, has a higher median family income and a much lower percentage of minority residents than the four surrounding counties.

3.2.2 Local Populations

Los Alamos County has two residential and related commercial areas. The Los Alamos town site has an estimated population of 11,400. The White Rock area, including the residential areas of White Rock and Pajarito Acres, has about 6,800 residents. There is a small, privately owned residential area, Royal Crest Trailer Park, surrounded by LANL Property. Royal Crest Trailer Park is situated approximately 1.2 km (3/4 mi) northeast of the proposed project area and has an estimated population of 500 persons (Morris 1994). The nearest public access road, Pajarito Road, is 300 m (985 ft) away. Approximately one-third of the 7,550 people employed by the University of California at LANL commute from other counties. The 1990 census conducted by the US Census Bureau indicates that approximately 215,000 people live in Los Alamos County and the adjoining counties of Rio Arriba, Santa Fe, and Sandoval.

3.3 ENVIRONMENTAL RESOURCES NOT AFFECTED

The proposed project would not involve new construction. It would not affect sensitive areas such as flood plains, wetlands, wildlife including wild horses and burros, coral reefs, tundras, prime farmland, wild and scenic rivers, or the habitat of state and federally listed threatened and endangered species, archaeological or cultural resources, or other sensitive areas (as defined in 10 CFR 1021). The proposed project would not require sitting, construction, or expansion of solid waste disposal, recovery, or treatment facilities. Chemical wastes and radioactive wastes would not be affected by the proposed action and are not discussed further. There would be no change in the quantity or type of air emissions, liquid effluents, or radioactive wastes generated at TA-55.

3.4 POTENTIALLY AFFECTED RESOURCES

For normal operations, the potentially affected resources of the proposed action would be land use for solid waste management. In case of an accident, air quality and human health effects could be affected.

3.4.1 Land Use for Waste Management

LANL has established procedures to be in compliance with all applicable laws and regulations for collecting, storing, processing, and disposing of routinely generated solid wastes at established facilities, on and off site.

Solid Waste Management

LANL's solid waste and trash is either discarded in the Los Alamos County Landfill or, where possible, released to the public for recycle. As one facet of waste minimization, LANL maintains a strong voluntary recycling initiative. In 1993, some 394 tons of paper materials were collected for recycling, which saved about 900 cubic m (30,000 cubic ft) of solid landfill space.

In 1993, Los Alamos County residents and businesses including LANL, contributed some 35,000 tons of garbage, trash, and rubble to the Los Alamos County Landfill. LANL's contribution was about one-third of that total material, 12,200 tons.

3.4.2 Human Health

LANL carries on a full program of monitoring radioactive exposures to members of the public and to members of the work force (LANL 1994). In 1992, the maximum calculated dose via the air pathway to a member of the public was 6.1 millirem (mrem), at a residence north of TA-53. The maximum allowable dose via the air pathway is set by the US Environmental Protection Agency (EPA) at 10 mrem (40 CFR 61, Subparts A and H). The average dose to a resident of the Los Alamos townsite was 0.12 mrem. The normal background radiation is 340 mrem.

Personnel at LANL who may be exposed to radioactive material are included in a personal monitoring program. Individuals wear film badges and other detectors as appropriate. Personnel also wear anti-contamination clothing including coveralls, respiratory protection, gloves, and booties, as needed. DOE limits occupational doses to 5 rem/year (DOE 1994). Worker exposure would be controlled under established TA-55 procedures that require doses to be kept ALARA, and that limit any individual dose to less than 2 rem/yr (TA-55 administrative limit). Workers would be monitored by health physics personnel from Environment, Safety, and Health Division. At TA-55, the average worker dose is 200 mrem/yr.

3.4.3 Air Quality

Radioactive Air Emissions

Information on radioactive air emissions from LANL is summarized in the annual Radioactive Air Emissions report (LANL 1993) and in the annual LANL Environmental Surveillance report (LANL 1995). Radioactive air emissions from TA-55 included tritium and plutonium. In 1992, the total activity of all radionuclides emitted into the air from all LANL laboratory stacks was approximately 73,300 Ci. Plutonium, as measured in LANL air emissions, includes several isotopes of plutonium (Pu^{238}, Pu^{239}, Pu^{240}, and Pu^{241}) and a decay product of plutonium (Am^{241}). In 1992, the activity of plutonium emissions from all LANL stacks combined totaled approximately 12 microcuries (μCi, 1 million μCi = 1 Ci) . Plutonium releases from TA-55 were 2.0 μCi in 1991 and 1.12 μCi in 1992 (LANL 1994).

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

Environmental consequences of this proposed action under normal operating conditions would be associated with disposing of construction rubble generated from modifying Building 185. Working conditions inside the PF-4 air lock and basement would be improved. Under accident conditions, worker dose and human health effects could also be affected.

4.1.1 Land Use for Waste Management

Clean-out and minor construction work on Building 185 could generate about 5 cubic m (175 cubic ft) of construction and demolition debris. This would be less than 3 tons of waste material (about one truckload). This material would be disposed in the Los Alamos County Landfill where it would be a small addition to the 12,200 tons of garbage, trash, and rubble disposed annually by LANL.

There would be no change in the quantity of TRU waste generated at PF-4 due to the proposed action.

4.1.2 Human Health and Personnel Protection

The TRU waste would contain plutonium, americium, and trace amounts of other radioisotopes. WIPP waste acceptance criteria specify that the dose rate on the surface of TRU waste containers must be less than 200 mrem/hr, although most of the handling operations involve considerably less exposure. Items removed from PF-4 must measure less than 20 disintegrations per minute of removable surface contamination.

Members of the public and non-involved LANL personnel would receive no dose from TRU container staging and certification operations during routine operations. At present, the public receives no dose from these operations.

4.1.2.1 Worker Protection

Exposure of involved workers would be controlled under DOE directives (DOE 1994), established TA-55 administrative procedures that require doses to be kept ALARA, and the goal to limit any individual dose to less than 2 rem/yr. Workers would be monitored by health physics personnel from LANL's Environment, Safety, and Health Division.

At present, some 10 LANL individuals manage TRU waste containers at PF-4. These activities are related to holding, staging, and shipping the TRU waste containers. The same ten individuals would be expected to work Building 185 part time. Drum staging operations would require about 20 person-hours/week. In Building 185, these individuals would be exposed to radiation of about 5 mrem/hr at a container surface and 0.7 mrem/hr at a distance of 2 m (6 ft).

The 10 workers involved with TRU drum management activities accumulate doses of about 50 mrem per year from all activities. The dose from drum staging operations is not measured separately. The cumulative worker dose over the life of the project (10 people, 50 mrem/yr for 20 years) would not exceed 10 person-rem. Based on an occupational risk factor of 400 fatal cancers per million person-rem (NRC 1991), workers in this proposed project and in the no-action alternative would not be expected to develop any excess fatal cancers from radiation exposure they may receive during normal operations.

It is not possible to estimate a decrease in the dose to other, non-involved individuals in the basement of PF-4 . However, their doses could be reduced somewhat because there would be a maximum of 100 rather than as many as 150 TRU waste containers in the basement.

4.1.3 Air Quality

Under normal operating conditions, there would be no radioactive emissions to the air as a consequence of the proposed actions.

4.2 ENVIRONMENTAL CONSEQUENCES OF THE NO-ACTION ALTERNATIVE

4.2.1 Land Use for Waste Management

No construction or demolition activities are proposed under the no-action alternative. No construction or demolition debris would be generated.

4.2.2 Human Health and Personnel Protection

There is no exposure from TRU container staging and certification operations to the public or to LANL personnel outside the PF-4 basement and airlock during routine operations in the no-action alternative.

4.2.2.1 Worker Protection

Exposure of involved workers would be continue to be controlled under DOE directives (DOE 1994), established TA-55 administrative procedures that require doses to be kept as ALARA, and the goal to limit any individual dose to less than 2 rem/yr. Workers would be monitored by health physics personnel from LANL's Environment, Safety, and Health Division.

At present, some 10 people stage drums in the airlock of the PF-4 basement, part-time. The radiation level at the surface of the containers averages 5 mrem/hr. At the nearest main traffic corridor 2 m (6 ft) distant, the radiation rate is 0.7 mrem/hr. The general background in the basement is 50 to 60 μrem/hr. Some personnel who work in unrelated jobs in the basement of PF-4 and some who walk the main traffic corridor near the containers receive some increment in dose, although it would be difficult to estimate the increment separately from the dose due to their other activities.

The 10 workers involved with drum staging on a part-time basis accumulate doses of about 50 mrem per year from all activities. Only part of this dose is from TRU drum staging operations; this part of the total dose is not measured separately. The cumulative worker dose (10 people, 50 mrem/yr for 20 years) would not exceed 10 person-rem. Based on an occupational risk factor of 400 fatal cancers per million person-rem (NRC 1991), workers in the no-action alternative would not be expected to develop any excess fatal cancers from radiation exposure they may receive during normal operations.

4.2.3 Air Quality

Under normal operating conditions, there would be no radioactive or nonradioactive emissions to the air as a consequence of the no-action alternative.

4.3 ABNORMAL EVENTS

Abnormal events that could cause the release of radioactive materials to the work area and the environment have been selected as a basis for comparing the risks from the proposed action and the no-action alternative. A scenario was developed to provide a bounding accident situation that could occur during the lifetime of the facility, assuming that standard operating procedures are followed and that all suppression and protection systems function according to design expectations.

4.3.1 Selection of Abnormal Event for Analysis

Several abnormal events were evaluated to determine the appropriate bounding accident that is likely to occur during the lifetime of the facility and that should be analyzed in detail. A fire is considered an unlikely event because flammable waste materials are strictly limited in quantity (DOE 1991a) and are sealed in metal containers. The wastes are therefore isolated from ignition sources. Although there may be some small residues of organic solvents in the containers, past monitoring with a combustible gas meter has shown that the gases in the containers are not ignitable. Furthermore, WIPP waste acceptance criteria and TA-54 waste acceptance criteria require that there be essentially no free liquid in the waste containers.

The accident that is considered to be the most probable cause for a release of radioactive material is a drum dropping from a height exceeding 1.2 m (4 ft), rupturing, and spilling a part of the contents.

4.3.2 Analysis of a Drum Drop and Spill Accident

In general, an accident involving forklift puncture of a drum is unlikely because the forklifts that are used to handle the containers are equipped with a drum-handling mechanism which completely covers the tines. Nonetheless, there are instances in which containers (on pallets) would be moved directly by a forklift without the drum-handling mechanism. The drum-drop accident is considered to be the most serious accident that is reasonably likely to occur. The event could occur in the no-action alternative or the proposed action. The potential releases and impacts are exactly the same. The accident may be more likely in the proposed action because there would be an additional handling operation when the containers are transferred out to the drum staging building. On the other hand, the cramped conditions in the airlock may make an accident somewhat more likely in the no-action alternative.

A drum rupture accident is being evaluated in a safety analysis study conducted for TA-54 operations. The release information presented here is adapted from that study. The accident occurs as follows: A drum falls from the platform of a forklift, a distance exceeding 1.2 m (4 ft) and ruptures. Some of the contents spill out. Because the drum contains solid waste with potentially very small amounts of organic solvent residues, a fire is not likely to occur. Very little of the material is expected to escape the drum because, after the rupture and initial release have occurred, there would be no continuing energy source to drive subsequent releases. Also, WIPP waste acceptance criteria (DOE 1991b) limits respirable fines in a container to one percent by weight of the waste. Assume that the drum contains 1,000 Ci, (assumed to be Pu^{239} for conservatism), and that the damage ratio is 10 percent, meaning that 100 Ci is released from the drum. Then

assume that 0.1 percent of the release is resuspended in air (airborne release fraction), and five percent of that is respirable, then 5 milliCurie (mCi) of ^{239}Pu particles within the respirable size range is released to the atmosphere. The most serious radiation exposure would occur to the operator of the forklift and is the same in the proposed action as the no-action alternative. Doses to the public would also be the same in the proposed action as in the no-action alternative because the accidents occur in a building (proposed action) or airlock with open door (no action alternative). Neither area has an atmospheric protection system.

Doses to a non-involved worker and the public who could be exposed from abnormal events were calculated using the DOE approved GENII-S model.

4.3.3 Consequences of Drum Drop and Spill

The operator of the forklift and any other personnel in the immediate vicinity of the breached drum leave the building or airlock within fifty seconds. These individuals are assumed not to be wearing respiratory protection. The building is not airtight and does not have an active ventilation or atmospheric filtration system. The airlock is open to the atmosphere. Therefore, approximately 5 mCi of respirable radionuclide would be released to the atmosphere, essentially at ground level.

A release of 100 mCi of Pu^{239} into the drum staging building, of which 5 mCi is in the respirable range, could result in a 50-yr committed effective dose equivalent (CEDE or *dose*) to the forklift operator of approximately 620 rem. A non-involved worker outside and downwind from the building could receive a dose as high as 360 rem, depending on location.

The ground-level atmospheric release of 5 mCi in the respirable range would result in a 50-yr. CEDE to the maximally exposed member of the public (assumed to be on Pajarito Road, south of TA-55) of approximately 240 mrem, assuming that the wind blows in that direction at the time of the release. The population of Los Alamos townsite, located north of TA-55, could receive a dose of 168 person-rem, assuming that the wind blows in that direction at the time of the release. The doses and associated risk of cancer fatalities to possibly exposed individuals and populations are summarized in Table 1.

The committed dose to the worker in the building is more than the 5 rem annual exposure limit in the DOE Radiation Protection Standards (DOE 1994) for normal operations. The possible committed dose to the maximally exposed member of the public exceeds both the Environmental Protection Agency radiation limit of 10 mrem/yr from airborne releases at DOE facilities (EPA 1989) and the 100 mrem DOE Radiation

Protection Standard for exposure from all pathways for members of the public (DOE 1990).

Table 1. Dose and Risk of Cancer Fatality

Receptor	Dose (CEDE)	Increased Risk of Cancer Fatality[a]
Involved Worker	620 rem	0.25 One in 4
Non-involved worker	360 rem	0.14 One in 7
Individual on Pajarito Road	240 mrem	0.00012 One in 8,300
Population of Los Alamos townsite (11,400)	168 person-rem	0.084 One in 12[b]

[a] NRC 1991 methodology.
[b] Risk is one in 12 that a single individual in the population of 11,400 suffers a premature death due to cancer as a result of this accident.

The consequences of the accident occurring in Building 185 and in the airlock (the no-action alternative) are exactly the same.

The probability of this accident and its consequences as presented here are very low. Drum ruptures happen less than once a year at LANL. The average radioactive contents in TRU waste drums from PF-4 average 400 Ci rather than 1,000 Ci. The WIPP acceptance criteria (DOE 1991b) impose a limit on non-immobilized particulate material and ash so release of 10 percent of the radioactive contents is unlikely. The involved workers could vacate the area in less than 50 seconds. The wind speed and direction used in calculating accident consequences were selected as worst case.

The dose calculation and risk assessment methodology are discussed in more detail in Appendix A.

4.4 CUMULATIVE IMPACTS

Under normal operating conditions, the only cumulative impact of the proposed action would be a single-year increase of 5 cubic m (175 cubic ft), less than 3 tons of construction rubble. This would be added to the LANL annual disposal of 12,200 tons of garbage, trash, and rubble disposed of in the Los Alamos County Landfill.

5.0 PERMITS

A permit from the EPA following 40 CFR Part 61, Subparts A and H, would not be required.

The LANL RCRA Part B permit would be written or revised to include the storage (staging) of TRU mixed waste in Building 185 at TA-55.

6.0 AGENCIES AND PERSON CONTACTED

No state or federal agencies outside DOE reviewed this environmental assessment.

7.0 REFERENCES

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8.0 GLOSSARY AND LIST OF TERMS, ABBREVIATIONS, AND ACRONYMS

ALARA	As low as reasonably achievable
AQCR	Air Quality Control Regulations
CEDE	Committed effective dose equivalent
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
Ci	Curie, a unit of radioactivity equal to 3.7×10^{10} disintegrations per second
DOE	United States Department of Energy
EA	Environment assessment
EIS	Environmental impact statement
EPA	US Environmental Protection Agency
FGE	Fissile gram equivalent, the amount of fissile material that yields the same number of fission events as a gram of Pu 239.
FONSI	Finding of no significant impact
ft	Feet, unit of linear measure
HEPA	High efficiency particulate air (air filter)
LANL	Los Alamos National Laboratory
m	Meter, unit of linear measure
mCi	MilliCurie, one thousandth of a Curie
mrem	Millirem, one thousandth of a rem
NEPA	National Environmental Policy Act
NMED	The State of New Mexico Environment Department
PF	Plutonium Facility, also called Technical Area (TA) 55
PF-4	Plutonium Facility Building 4, a plutonium laboratory building
PF-41	Plutonium Facility Building 41, the Nuclear Material Storage Facility

rem	The amount of ionizing radiation required to produce the same biological effect as one roentgen of high-penetration x-ray; unit of dose equivalent for a single individual, used in the field of radiation dosimetry.
RCRA	Resource Conservation and Recovery Act
Solid TRU	Solid TRU includes laboratory and processing waste and solidified liquid waste. It does not include unsolidified liquid waste.
SWEIS	Site-wide Environmental Impact Statement
TA	Technical Area at LANL
TRU Waste	Transuranic Waste. Waste that is contaminated with alpha-emitting radionuclides with atomic number (number of neutrons) greater than uranium (transuranic), half lives greater than 20 years, and concentrations greater than 100 nanocuries per gram of waste
UBC	Uniform Building Code
WIPP	The Waste Isolation Pilot Plant in Carlsbad, New Mexico.
WAC	Waste Acceptance Criteria
μCi	MicroCurie, one millionth of a Curie

9.0 EXPONENTIAL NOTATION

Some numerical values in the text are expressed in exponential notation. An exponent is the power to which a number or expression is raised. The following examples in Table 3 illustrate the use of exponential notation, as well as examples of prefixes and symbols used with units of measurement to denote magnitude. For instance, a kilogram (kg) is one thousand (1×10^3) grams; a milligram (mg) is one thousandth (1×10^{-3}) of a gram. Units of measurement are defined in the glossary (Section 8).

Table 3. Exponential Notation

Factor by which a unit is multiplied	Number	Prefix	Symbol
1×10^{12}	1,000,000,000,000	tera	T
1×10^{9}	1,000,000,000	giga	G
1×10^{6}	1,000,000	mega	M
1×10^{3}	1,000	kilo	k
1×10^{2}	100	hecto	h
1×10^{1}	10	deka	da
1×10^{0}	1		
1×10^{-1}	0.1	deci	d
1×10^{-2}	0.01	centi	c
1×10^{-3}	0.001	milli	m
1×10^{-6}	0.000001	micro	μ
1×10^{-9}	0.000000001	nano	n
1×10^{-12}	0.0000000000001	pico	p

Appendix A

Dose and Risk Calculation Methodology

Dose Calculation Methodology

The airborne source term is calculated by using the following formula as recommended by the one of the standard handbooks for airborne release fractions/rates and respirable fractions for nonreactor nuclear facilities (DOE 1994).

$$\text{Source Term (Q)} = \text{MAR} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF}$$

where:

MAR	=	Material-at-Risk
DR	=	Damage Ratio
ARF	=	Airborne Release Fraction
RF	=	Respirable Fraction, and
LPF	=	Leakpath Factor.

The MAR is the amount of radionuclides (in grams or curies of activity) available to be acted upon by a given physical stress. In the case of the proposed action, MAR represents the maximum quantity of ^{239}Pu available for each accident scenario. To be conservative, the MAR is assumed to be 1.000 Ci ^{239}Pu. The DR is the fraction of the MAR actually impacted by the accident-generated conditions. In the accident scenarios evaluated for the proposed action, the DR is conservatively assumed to be 0.1, e.g. 10 percent of the MAR is acted upon and available during the accident. The ARF is the coefficient used to estimate the amount of radioactive material suspended in air as an aerosol and thus available for transport. The ARF is assumed to be 0.1 percent, or 0.001 of the material released. There is no force to resuspend the released material, such as fire or tornado. The RF represents the fraction of airborne radionuclides as particles that can be transported through air and inhaled into the human respiratory system. The RF is assumed to be 5 percent, or 0.05 of the ARF. The ARF and RF fractions used for these calculations were determined by the recommended values from the DOE handbook (DOE 1994). The LPF is the fraction of radionuclides in the aerosol transported through some confinement layer or otherwise reduced by other filtration mechanisms. The LPF is assumed to be 1, meaning that nothing confines the release as neither Building 185 nor the airlock has an air filtration system.

$$\text{Source Term} = (1{,}000\ \text{Ci}) * (0.1) * (0.001) * (0.05) * (1.0)$$
$$Q = 5\ \text{mCi}$$

Committed effective dose equivalent (CEDE or dose) to the forklift operator :

$$CEDE = Q \times RF \times DF \times t \times DCF$$

where:

Q (Source term, respirable ^{239}Pu)	=	5 mCi
RF (breathing rate)	=	3.3×10^{-4} cubic meters/second
DF (dispersion factor)	=	0.03 /cubic meter
t (time of involved worker exposure)	=	50 seconds
DCF (dose conversion factor)	=	2.5×10^{-5} rem/mCi

$CEDE = (5\ mCi)*(0.03/m^3)*(3.3 \times 10^{-4}\ m^3/sec)*(50\ sec)*(2.5 \times 10^5\ rem/mCi)$

CEDE = 618 rem (round up to 620 rem)

Similar calculations are made using the DOE-approved computer model GENII-S for the non-involved worker, the nearest member of the public on Pajarito Road, and for the population of Los Alamos townsite.

Risk Calculation Methodology

"Health effect" is used as a synonym for "risk" in this discussion and is directly proportional to the total effective dose equivalent. Health effect and risk mean the chance of exposed individual(s) developing additional fatal cancers as a result of the exposure to radioactive materials. The linear dose response and relative risk models discussed in "The 1990 Report of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR-V)" are used to establish the risk factors (BEIR 1990). These models extrapolate fatal tumor risks to future periods and assume the risk to be proportional to the natural cancer incidence, which generally increases with age. Use of these risk factors is required by DOE in their EA preparation recommendations (DOE 1993).

BEIR-V relates excess fatal cancer cases to dose, giving a lifetime risk factor of a radiation-induced cancer fatality of about 4×10^{-4} fatal cancers per rem for workers and 5×10^{-4} fatal cancers per rem for members of the general population. The higher value for the public takes into account the higher sensitivity and longer period of exposure for the younger ages present in the general population (NRC 1991). Where the dose to an entire population group is estimated and stated in person-mrem, the risk factor is expressed as 5×10^{-4} fatal cancers per person-rem. The risk is in terms of added chances of cancer mortality over the entire population rather than an individual but is used in EA risk calculations to estimate the probability of an exposed individual's developing fatal cancer.

An occupational risk factor of 4×10^{-4} excess cancer fatalities per rem is equivalent to an individual risk for cancer mortality of one chance in 2,500,000 for a dose of one mrem. The risk factor for the public of 5×10^{-4} excess cancer fatalities per rem is equivalent to an individual risk for cancer mortality of one chance in 2,000 for a dose of one rem. The health effect is thus expressed as the number of chances of an individual developing a fatal cancer as a result of the CEDE in rem. For a worker population group, the risk factor of 4×10^{-4} excess cancer fatalities per rem is equivalent to a group risk of one chance in 2,500 for a dose of one rem to cause a single additional individual within that group to die of cancer. For a population group the risk factor of 5×10^{-4} excess cancer fatalities per person-rem is equivalent to a group risk of one chance in 2,000 for an exposure of one rem to cause a single additional individual within that group to die of cancer.

Probability of a single excess cancer fatality in the exposed group of workers = CEDE $\times 400 \times 10^{-4}$/rem

= 10 person-rem * 400×10^{-4}/rem

= 0.4

References

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