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Created By:	Nicole M. Valerio/USERS/LANL
File name:	Target-ERID # for Domino.txt
Version:	1.0
Document Type:	RPF Record
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Document Details:

Title:	ERID-094156 1) RADIOACTIVE WASTE INVENTORY FOR LOS ALAMOS TECHNICAL AREA 54, (TA-54) MATERIAL DISPOSAL AREA G (MDA G) LA-UR-05-6996
ERID Number.StartPage:	ERID-094156
Office of Record:	ENV-ERSS
Date Received:	11/28/2006
Official Use Only:	N
Page Count:	128
Record Type:	Report
Document Date:	09/01/2005
To:(Addressees - Organization) *(separate multiple values with semicolons)*	N/A
From:(Senders - Organization) *(separate multiple values with semicolons)*	ROBERT SHUMAN
Other Document Number(s): *(separate multiple values with semicolons)*	LA-UR-05-6996
TA: *separate multiple values with semicolons)*	54
PRS Number(s): *(separate multiple values with semicolons)*	N/A
Record Box Number:	

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Title: RADIOACTIVE WASTE INVENTORY FOR LOS ALAMOS NATIONAL LABORATORY TECHNICAL AREA 54, MATERIAL DISPOSAL AREA G

Author(s): Rob Shuman

Submitted to: U.S. Department of Energy

Los Alamos
NATIONAL LABORATORY

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Acronyms and Abbreviations

CMP	Corrugated metal pipe
CMPAC	Corrugated metal pipe, asphalt coated
D&D	Decontamination and decommissioning
DOE	U.S. Department of Energy
DU	Depleted uranium
EBR-II	Experimental Breeder Reactor II
EPA	U.S. Environmental Protection Agency
ER	Environmental restoration
HEPA	High efficiency particulate air (filter)
LA	Los Alamos
Laboratory	Los Alamos National Laboratory
LAMPF	Los Alamos Meson Physics Facility
LAMPRE	Los Alamos Molten Plutonium Reactor Experiment
LANL	Los Alamos National Laboratory
LLW	Low-level (radioactive) waste
MAP	Mixed-activation products
MDA	Material Disposal Area
MFP	Mixed-fission products
PCB	Polychlorinated biphenyl
PTC	Sodium polythiocarbonate
SPI	Steel pipe insert
SRL	Size Reduction Lab
TA	Technical Area
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSFF	Tritium Science and Fabrication Facility
TSTA	Tritium Systems Test Assembly
UHTREX	Ultra-high temperature reactor experiment
UL	Unlined
WETF	Weapons Engineering Tritium Facility
WIPP	Waste Isolation Pilot Plant

1.0 Introduction

Los Alamos National Laboratory (LANL or the Laboratory) generates radioactive waste as a result of various activities. Operational waste is generated at the Laboratory from a wide variety of research and development activities including nuclear weapons development, energy production, and medical research. Environmental restoration (ER) and decontamination and decommissioning (D&D) waste is generated as contaminated sites and facilities at the LANL undergo cleanup or remediation. The majority of this waste is low-level radioactive waste (LLW) and is disposed of at the Technical Area (TA) 54, Material Disposal Area (MDA) G.

U.S. Department of Energy (DOE) Order 435.1 (DOE, 1999a) requires that radioactive waste is managed in a manner that protects worker and public health and safety, and the environment. To comply with this order, DOE field sites must prepare and maintain site-specific radiological performance assessments for LLW disposal facilities that accept waste after September 26, 1988. Furthermore, sites are required to conduct composite analyses for disposal facilities that receive waste after September 26, 1988. These composite analyses account for cumulative impacts of all waste that has been (or will be) disposed of at the facilities and other sources of radioactive material that may interact with the facilities.

In compliance with DOE Order 5820.2A (DOE, 1988), the predecessor to Order 435.1, the Laboratory issued the MDA G performance assessment and composite analysis in 1997 (Hollis et al., 1997). The 1997 analyses are being revised to incorporate new knowledge about the MDA G facility and site, and to update the modeling approaches used to project the long-term performance of MDA G. This report documents the steps taken to update the radiological inventory.

The waste projections developed through this inventory characterization will be input directly into the models used to revise the performance assessment and composite analysis. In terms of the performance assessment, the inventory includes all LLW that has been disposed of at MDA G since September 26, 1988 as well as the LLW that will require disposal until the facility closes in 2044. The waste inventory for the composite analysis includes all radioactive waste disposed of at MDA G since the facility opened in 1957 as well as the projected LLW that will require disposal through 2044. In brief, this characterization effort:

- Establishes the types of waste that have been, or will be, disposed of at MDA G
- Briefly describes the methods used to dispose of the waste
- Estimates the total volume and activity of the waste as well as the radionuclide-specific inventories present in the material

Following this brief introduction (Section 1), Section 2 of this report summarizes the types of waste that have been disposed of at MDA G, describes the disposal units used to contain the waste, and considers the operational practices used to place and isolate the waste. The methods used to estimate the waste inventories for the performance assessment and composite analysis are described in Section 3. Inventory projections are presented in Section 4, along with a discussion of the uncertainties associated with these estimates. In addition, there are three attachments to this report: *Attachment I* establishes the bases for eliminating specific radionuclides from the inventory, *Attachment II* presents pre-1971 disposal records for MDA G shafts, and *Attachment III* provides additional details regarding the methodology used for estimating radionuclide-specific activities.

2.0 Background: Waste Characteristics and Disposal Technologies

The types of waste disposed of at MDA G and the methods used to isolate the waste from the environment have influenced the approach adopted to develop the performance assessment and composite analysis inventory projections. This section provides background information including a general description of the waste and the disposal technologies and operational procedures used at the site.

Waste disposed of at MDA G includes operational or routine waste, nonroutine waste, and waste from ER and D&D activities at the Laboratory. Operational waste consists of a wide range of materials including compactable trash (e.g., paper, cardboard, and plastic), rubber, glass, disposable protective clothing, solidified powders and ash, animal tissue, and suspect radioactive waste. Nonroutine waste includes classified waste, uranium chips from LANL shops, and pieces of heavy equipment such as dump trucks (Rogers, 1977). Environmental restoration and D&D waste includes equipment and scrap metal, demolition debris, soil, concrete, asphalt, asbestos, and polychlorinated biphenyl (PCB)-contaminated materials. The MDA G facility does not accept free liquids for disposal.

The nature of the waste disposed of at MDA G has changed over the facility's lifetime. Waste that, under current definitions, is considered to be transuranic (TRU) was disposed of at the facility through 1970. Since then, the vast majority of TRU waste generated at the Laboratory has been segregated and retrievably stored for permanent disposal at the Waste Isolation Pilot Plant (WIPP), although small amounts of TRU waste were disposed of at MDA G between 1971 and 1979. Most of the TRU waste awaiting disposal at the WIPP is stored at MDA G under large domes that have been placed on asphalt pads. Some of the TRU waste is stored in below-grade retrievable arrays, including material placed in pits 9 and 29, trenches A–D, and shafts 200–232 and 302–306.

Waste that, under current definitions, qualifies as mixed LLW was placed in MDA G pits and shafts through 1985. Mixed TRU waste was routinely disposed of at MDA G prior to 1971; smaller quantities of mixed TRU waste were disposed of between 1971 and 1979. Since 1986, when the U.S. Environmental Protection Agency (EPA) affirmed its authority over the regulation of the hazardous component of mixed LLW, the vast majority of the mixed LLW has been segregated from LLW and sent off site for treatment and/or disposal. Small amounts of mixed LLW were inadvertently placed in a single pit and shaft between 1986 and 1990; no mixed waste has been disposed of at MDA G since 1990. In addition to LLW, MDA G is permitted to accept low-level Toxic Substances Control Act (TSCA) waste (i.e., asbestos and PCBs). Solid LLW and low-level TSCA waste are currently the only waste types disposed of at MDA G.

Two major types of disposal units are used at MDA G: pits and shafts. Routine LLW (e.g., operational, ER, and D&D waste) is placed in disposal pits; these large, generally rectangular units are excavated using heavy equipment. Disposal pits are set back at least 15 m (50 ft) from the nearest canyon rim and are dug no deeper than 3 m (10 ft) above the canyon floor. To date, no pits are deeper than 19 m (60 ft) although future units may have a total depth of about 25 m (80 ft). Pit disposal began in the second quarter of 1957, when nonroutine waste was placed in pit 1 (Rogers, 1977). The disposal of routine radioactive waste began in January 1959.

Prior to the mid-1990s, waste disposed of in pits was typically placed in lifts; each layer of waste was covered with uncontaminated crushed tuff and compacted by driving heavy equipment over the crushed tuff. Exceptions to this approach occurred, predominantly when the possibility existed that the waste might be retrieved at a later date. Current operational procedures require that waste other than bulk soils and debris be packaged prior to disposal. Bulk materials are placed directly in the disposal pits, and may be used to fill void spaces between and within waste containers.

Shafts were first used for waste disposal at MDA G in April 1966 (Rogers, 1977). A regulatory requirement for some types of waste, disposal shafts are used to provide additional shielding of waste with high external radiation levels, to facilitate placement using remote handling techniques, and to accommodate special packaging requirements. The shafts are drilled using augers and, like the pits, are set back at least 15 m (50 ft) from the nearest canyon rim, and are dug no deeper than 3 m (10 ft) above the adjacent canyon floor. Shaft diameters generally range from 0.3 to 6 m (1 to 20 ft). Waste packages are lowered into the shafts and stacked on top of one another. Crushed tuff may be added as backfill around the waste packages, thereby reducing void spaces in the disposal units.

From 1957 through December 31, 2003, 35 pits and almost 220 shafts were used for the disposal of radioactive waste at MDA G. Table 1 provides the periods of operation, dimensions, and types of waste that have been placed in the 35 pits during this time period; Table 2 provides similar information for the disposal shafts. Three of the 35 disposal pits — pits 31, 38, and 39 — were open and receiving waste in late 2004. These three pits are used for the disposal of operational, ER, and D&D waste generated at the Laboratory. Approximately 40 shafts were open and receiving waste in early 2004.

Table 1
Historical Use and General Characteristics of Disposal Pits at Material Disposal Area G

Pit No.	Operational Period	Length × Width × Depth (m)	Field Measured Pit Volume (m^3)	Waste Volume (m^3)	Waste Description
1	Jan. 1959 – April 1961	188 x 34 x 6	2.8E+04	4.2E+03	Wing tanks from Kirtland Air Force Base, dry boxes, and "normal trash."
2	April 1961 – July 1963	188 x 32 x 8	3.3E+04	4.9E+03	Classified Bendix waste, 0.21 m^3 (55 gal) drums, equipment, DU, and soil.
3	June 1963 – March 1966	200 x 35 x 10	4.3E+04	7.2E+03	Miscellaneous material, lumber, pipe, 0.21 m^3 (55 gal) drums, D&D waste, DU, Bendix classified waste, and soil from TA-10.
4	Jan. 1966 – Dec. 1967	183 x 34 x 10	3.4E+04	6.3E+03	D&D waste, graphite, wooden boxes, DU, 0.21 m^3 (55 gal) drums, classified Bendix waste, and equipment.
5	Jan. 1967 – March 1974	183 x 30 x 9	3.2E+04	5.1E+03	Scrap material, D&D waste, graphite hoppers, sludge drums (possibly aqueous solution from TA-50), and equipment.
6	Jan. 1970 – Aug. 1972	183 x 34 x 8	3.4E+04	5.1E+03	Miscellaneous scrap, wood, and D&D waste; covered with topsoil from TA-1 with up to 20 pCi/g plutonium contamination.
7	March 1974 – Oct. 1975	183 x 15 x 9	1.3E+04	3.3E+03	Low-level TRU waste; replaced pit 17 for low-level TRU waste in 1974. Covered with topsoil from TA-1 with up to 20 pCi/g plutonium contamination.
8	Sept. 1971 – May 1974	122 x 8 x 8	5.0E+03	1.8E+03	0.21 m^3 (55 gal) drums of sludge, nonretrievable TRU waste, and drums from TA-50 (aqueous and nonretrievable TRU waste).
9	Nov. 1974 – Nov. 1979	122 x 9 x 6	6.9E+03	4.8E+00 [a]	Drums and fiberglass crates containing retrievable TRU waste (>10 nCi/g Pu-239 or U-233 or >100 nCi/g Pu-238).
10	May 1979 – March 1980	116 x 17 x 8	1.2E+04	3.1E+03	Building debris, lab wastes, and sludge drums (from TA-50 dewatering, possibly aqueous waste).

Source: LANL, 2003, adapted from Table B-1.

DU = Depleted uranium
TRU = Transuranic
--- = No waste volume listed: more material is expected to be placed in the pit.

D&D = Decontamination and decommissioning
MFP = Mixed-fission products
PCB = Polychlorinated biphenyl

TA = Technical Area (e.g., TA-10)
MAP = Mixed-activation products
UHTREX = Ultra-high temperature reactor experiment

[a] The listed waste volume for pit 9 represents LLW; this pit was used primarily for the retrievable storage of TRU waste.

[b] "Present" indicates late 2004

Table 1 (Continued)
Historical Use and General Characteristics of Disposal Pits at Material Disposal Area G

Pit No.	Operational Period	Length × Width × Depth (m)	Field Measured Pit Volume (m³)	Waste Volume (m³)	Waste Description
11	Never excavated				
12	Sept. 1971 – Dec. 1975	122 x 8 x 8	5.6E+03	1.8E+03	Non-retrievable TRU waste; contained 30 0.21 m³ (55 gal) drums of retrievable TRU waste that were later transferred to pit 9.
13	Nov. 1976 – Sept. 1977	122 x 13 x 9	9.3E+03	1.5E+03	Uranium, MFP, and MAP.
14	Never excavated				
15	June 1997 – Nov. 2001	107 x 15 x 9	9.0E+03	3.6E+03	Lab trash, building debris, scrap metal, and filter media waste.
16	Sept. 1971 – Aug. 1975	122 x 8 x 8	6.2E+03	1.7E+03	Crates and drums containing uranium-contaminated wastes.
17	Aug. 1972 – March 1974	183 x 14 x 7	1.3E+04	3.8E+03	Low-level plutonium TRU waste, misc. scrap wastes, crates, and filter plenum.
18	Feb. 1978 – Aug. 1979	183 x 23 x 12	3.6E+04	9.4E+03	Contaminated dirt, lab wastes, noncompactable waste, D&D waste, and drums.
19	Nov. 1975 – Aug. 1979	47 x 9 x 5	1.0E+03		Asbestos and carcinogens.
20	Nov. 1975 – Oct. 1977	183 x 22 x 11	2.9E+04	1.1E+04	Lab waste, oil, sludge drums, trash, and contaminated dirt.
21	Aug. 1972 – Dec. 1974	123 x 17 x 8	1.0E+04	2.8E+03	Uranium, classified material, boxes, drums, and scrap metal.
22	Sept. 1976 – March 1978	126 x 17 x 10	1.4E+04	2.9E+03	Filter plenum, sludge drums (possibly aqueous waste from TA-50), lab waste, graphite fuel rods, and contaminated soil.
23	Never excavated				

Source: LANL, 2003, adapted from Table B-1.

DU = Depleted uranium
TRU = Transuranic
--- = No waste volume listed; more material is expected to be placed in the pit.
D&D = Decontamination and decommissioning
MFP = Mixed-fission products
PCB = Polychlorinated biphenyl
TA = Technical Area (e.g., TA-10)
MAP = Mixed-activation products
UHTREX = Ultra-high temperature reactor experiment

[a] The listed waste volume for pit 9 represents LLW; this pit was used primarily for the retrievable storage of TRU waste.
[b] "Present" indicates late 2004

Table 1 (Continued)
Historical Use and General Characteristics of Disposal Pits at Material Disposal Area G

Pit No.	Operational Period	Length × Width × Depth (m)	Field Measured Pit Volume (m^3)	Waste Volume (m^3)	Waste Description
24	July 1975 – Nov. 1976	183 x 18 x 9	1.8E+04	5.6E+03	Graphite, lab wastes, and 22 truckloads of soil; uranium, tritium, MFP, and MAP.
25	Jan. 1980 – May 1981	120 x 31 x 12	3.6E+04	5.0E+03	Reactor control rods, D&D waste, scrap drums, lab wastes, test drums, and PCB-contaminated waste.
26	Feb. 1984 – Feb. 1985	94 x 30 x 11	1.7E+04	3.3E+03	Building debris, TRU waste culverts, asbestos, alpha box soil, lumber, and PCBs.
27	May 1981 – July 1982	122 x 24 x 14	2.1E+04	5.7E+03	Lab waste, contaminated soil and pipe, D&D waste, PCBs, and unknown chemical waste.
28	Dec. 1981 – April 1983	101 x 25 x 12	1.6E+04	3.4E+03	Barium nitrate, PCB-contaminated soil, lab waste, equipment, transformers, clay pipes, building debris, and uranium graphite.
29	Oct. 1984 – Oct. 1986	201 x 24 x 15	3.5E+04	7.5E+03	TRU cement paste (retrievable), D&D soil, glove boxes, plywood boxes, asbestos, PCBs, and unknown chemical waste.
30	Oct. 1988 – June 1990	173 x 12 x 11	3.3E+04	1.0E+04	Asbestos, PCBs, and unknown chemical waste.
31	June 1990 – Present [b]	85 x 16 x 8	7.2E+03	---	Asbestos, asbestos-contaminated debris, and contaminated soil; operational as of 2004.
32	Nov. 1985 – Aug. 1987	158 x 23 x 16	2.8E+04	4.1E+03	PCB-contaminated asphalt, transformers, contaminated soil, glove boxes, plywood boxes, capacitors, and building debris.
33	Nov. 1982 – July 1984	130 x 35 x 12	4.6E+04	5.9E+03	Beryllium in stainless steel, lab waste, building debris, asbestos, Noncombustible trash, PCBs, and unknown chemical waste.
34	Never excavated				

Source: LANL, 2003, adapted from Table B-1.

DU = Depleted uranium
TRU = Transuranic
--- = No waste volume listed: more material is expected to be placed in the pit.
D&D = Decontamination and decommissioning
MFP = Mixed-fission products
PCB = Polychlorinated biphenyl
TA = Technical Area (e.g., TA-10)
MAP = Mixed-activation products
UHTREX = Ultra-high temperature reactor experiment

[a] The listed waste volume for pit 9 represents LLW; this pit was used primarily for the retrievable storage of TRU waste.
[b] "Present" indicates late 2004

Table 1 (Continued)
Historical Use and General Characteristics of Disposal Pits at Material Disposal Area G

Pit No.	Operational Period	Length × Width × Depth (m)	Field Measured Pit Volume (m³)	Waste Volume (m³)	Waste Description
35	June 1987 – Feb. 1988	111 x 25 x 12	1.6E+04	2.6E+03	Compactable trash, plywood boxes, asbestos, lab waste, PCBs, and unknown chemical waste.
36	Jan. 1988 – Dec. 1988	133 x 25 x 13	2.1E+04	3.4E+03	Plywood boxes, compactable trash, rubble, building waste, beryllium, and PCB-contaminated soil.
37	April 1990 – April 1997	223 x 25 x 19	4.4E+04	1.8E+04	UHTREX reactor vessel and stack, asbestos, PCBs, and unknown chemical waste.
38	Sept. 1994 – Present [b]	219 x 40 x 18	5.6E+04	---	Lab trash, contaminated soil, building debris, scrap metal, and filter media waste; operational as of 2004.
39	Aug. 1993 – Present [b]	88 x 69 x 14	2.9E+04	---	Lab trash, contaminated soil, building debris, and scrap metal; operational as of 2004.

Source: LANL. 2003, adapted from Table B-1.

DU = Depleted uranium
TRU = Transuranic
--- = No waste volume listed; more material is expected to be placed in the pit.
D&D = Decontamination and decommissioning
MFP = Mixed-fission products
PCB = Polychlorinated biphenyl
TA = Technical Area (e.g., TA-10)
MAP = Mixed-activation products
UHTREX = Ultra-high temperature reactor experiment

[a] *The listed waste volume for pit 9 represents LLW; this pit was used primarily for the retrievable storage of TRU waste.*

[b] *"Present" indicates late 2004*

Table 2
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
1	1966 – 1967	0.61 / 8	UL	2.2E+00	1.8E+00	Cell trash, irradiated metal, and animal tissue
2	1966 – 1967	0.61 / 8	UL	2.2E+00	1.2E+00	DU chips, animal tissue, and irradiated plutonium cell waste
3	1966 – 1967	0.61 / 8	UL	2.2E+00	1.1E+00	Plutonium-contaminated Na and metal, and neutron generators
4	1967 – 1968	0.61 / 8	UL	2.2E+00	1.3E+00	Uranium-contaminated metal, U-238 samples, and DU
5	1967 – 1968	0.61 / 8	UL	2.2E+00	8.4E-01	DU, tritium-contaminated materials, and U-238 contaminated metal
6	1967 – 1968	0.61 / 8	UL	2.2E+00	5.8E-01	Tritium contaminated materials and U-235
7	1967 – 1968	0.61 / 8	UL	2.2E+00	1.6E+00	Animal tissue, plasma thermocouple waste, and tritium DU
8	1968 – 1969	0.61 / 8	UL	2.2E+00	6.3E+00	Plutonium cell waste, animal tissue, and end boxes
9	1968 – 1969	0.61 / 8	UL	2.2E+00	2.0E+00	Hot cell waste, plutonium cell waste, EBR-II waste, and fuel elements
10	1969	0.61 / 8	UL	2.2E+00	1.5E+00	Animal tissue, Pu-239 waste, and uranium-contaminated chemicals

Source: LANL, 2003, adapted from Table B-3.

UL = Unlined
CMP = Corrugated metal pipe
MAP = Mixed activation products
CMPAC = Corrugated metal pipe, asphalt coated
LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
LAMPF = Los Alamos Meson Physics Facility
PCB = Polychlorinated biphenyl
EBR-II = Experimental Breeder Reactor II
MFP = Mixed fission products
HEPA = High efficiency particulate air
SPI = Steel pipe insert

[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts: LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume: the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
11	1967 – 1969	0.91 / 8	UL	5.0E+00	2.0E+00	Pee Wee waste and trash, U-235 cell waste, and graphite
12	1966 – 1970	0.91 / 8	UL	5.0E+00	2.3E+00	Cell waste, rover waste, and tritium
13	1966 – 1970	0.91 / 8	UL	5.0E+00	3.4E+00	Animal tissue, EBR hardware, and reactor parts
14	1966 – 1969	0.3 / 8	CMP	5.6E-01	7.6E-01	U-235 contaminated vermiculite and neutralized solution HCL+U-235
15	1969 – 1970	0.3 / 8	CMP	5.6E-01	1.4E-01	Tritium in H_3PO_4 and hot cell waste
16	1969	0.3 / 8	CMP	5.6E-01	1.1E-01	Tritium
17	1970 – 1974	0.3 / 8	CMP	5.6E-01	1.8E-01	Tritium pump and U-235 in Na
18	1970 – 1973	0.3 / 8	CMP	5.6E-01	3.3E-01	Neutralized Na and Cs-137+Ba-140
19	1971 – 1974	0.3 / 8	CMP	5.6E-01	7.6E-02	Pu-239 solution and reacted Pu-239
20	1974 – 1975	0.3 / 8	CMP	5.6E-01	7.6E-02	Sorbed Pu-239 solution
21	1985	0.3 / 8	CMP	5.6E-01	3.8E-03	Radioactive sources
22	1980 – 1993	0.3 / 8	CMP	5.6E-01	1.9E-01	Radioactive sources
23	1980	0.3 / 8	CMP	5.6E-01	2.8E-02	Radioactive sources
24	1969 – 1972	0.61 / 8	UL	2.2E+00	1.9E+00	Animal tissue, DU, and unloaded fuel elements
25	1969 – 1971	0.61 / 8	UL	2.2E+00	1.2E+00	DU, U-238 residue, and U-238 contaminated metal

Source: LANL. 2003. adapted from Table B-3.

UL = Unlined
CMP = Corrugated metal pipe
MAP = Mixed activation products
CMPAC = Corrugated metal pipe. asphalt coated
LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
LAMPF = Los Alamos Meson Physics Facility
PCB = Polychlorinated biphenyl
EBR-II = Experimental Breeder Reactor II
MFP = Mixed fission products
HEPA = High efficiency particulate air
SPI = Steel pipe insert

[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts: LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume: the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
26	1969 – 1970	0.61 / 8	UL	2.2E+00	1.6E+00	Hot cell trash, fuel elements, and DU-contaminated metal
27	1970	0.61 / 8	UL	2.2E+00	3.6E-01	Irradiated material and DU-contaminated material
28	1970	0.61 / 8	UL	2.2E+00	8.4E-01	Los Alamos notebooks and U-235 residues
29	1970 – 1971	0.61 / 8	UL	2.2E+00	7.6E-01	Thermocouple waste and U-235 residues
30	1970 – 1985	0.61 / 8	UL	2.2E+00	5.0E-01	Animal tissue and Pu-239 hot cell waste
31	1970 – 1971	0.61 / 8	UL	2.2E+00	1.3E+00	DU
32	1970 – 1971	0.61 / 8	UL	2.2E+00	1.6E+00	LAMPRE-II lines and valves, animal tissue, and irradiated stainless steel
33	1970 – 1971	0.61 / 8	UL	2.2E+00	5.1E-01	Pu-239 hot cell waste
34	1970 – 1972	1.8 / 18	UL	4.8E+01	2.6E+01	U-contaminated oil
35	1971 – 1985	0.91 / 12	UL	8.0E+00	2.4E+00	Hot cell wastes, animal tissues, herbicide containers, and fission products
36	1970 – 1985	0.91 / 12	UL	8.0E+00	2.6E+00	Hot cell wastes and spallation products
37	1970 – 1985	0.91 / 12	UL	8.0E+00	4.3E+00	Animal and chemical wastes
38	1970 – 1974	0.91 / 12	UL	8.0E+00	1.9E+00	Rover reactor parts and LAMPRE-II tank
39	1970 – 1973	1.8 / 18	UL	4.8E+01	1.6E+01	Tritium-contaminated equipment
40	1971	0.61 / 8	UL	2.2E+00	1.1E+00	Animal tissue

Source: LANL, 2003, adapted from Table B-3.

UL = Unlined
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LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
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PCB = Polychlorinated biphenyl
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MFP = Mixed fission products
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[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts; LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume; the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
41	1971 – 1972	0.61 / 8	UL	2.2E+00	3.8E+01	Animal tissue and graphite
42	1971 – 1972	0.61 / 8	UL	2.2E+00	1.8E+00	Animal tissue and uranium-contaminated metal
43	1971 – 1972	0.61 / 8	UL	2.2E+00	1.5E+00	Uranium-contaminated metal and DU
44	1971 – 1972	0.61 / 8	UL	2.2E+00	1.7E+00	Animal tissue, Pu-239 contaminated vermiculite, and DU with graphite
45	1971 – 1972	0.61 / 8	UL	2.2E+00	1.8E+00	Plutonium-contaminated steel and U-235 residues
46	1972	0.61 / 8	UL	2.2E+00	1.8E+00	Animal tissue and Pu-239 contaminated steel
47	1972	0.61 / 8	UL	2.2E+00	1.0E+00	Animal tissue, contaminated metal, and fuel waste
48	1972	0.61 / 8	UL	2.2E+00	1.1E+00	Hot cell trash and fuel waste
49	1972	0.61 / 8	UL	2.2E+00	7.9E-01	Animal tissue
50	1974 – 1976	1.8 / 18	UL	4.8E+01	1.9E+01	Tritium
51	1975	0.61 / 8	UL	2.2E+00	3.6E-01	Hot cell waste
52	1975 – 1976	0.61 / 8	UL	2.2E+00	2.0E+00	Plutonium, uranium, MFP, MAP, and hot cell wastes
53	1975 – 1976	0.61 / 8	UL	2.2E+00	8.3E-01	MFP, cell wastes, Pu-239, and U-235
54	1976	0.61 / 8	UL	2.2E+00	4.5E-01	MFP and cell trash
55	1976 – 1977	0.61 / 8	UL	2.2E+00	1.4E+00	Hot cell trash

Source: LANL, 2003, adapted from Table B-3.

UL = Unlined
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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
56	1977	0.61 / 8	UL	2.2E+00	7.5E-01	Cell waste and contaminated parts from SRL
57	1977	0.61 / 8	UL	2.2E+00	3.1E-01	Hot cell waste
58	1972 – 1973	0.91 / 8	UL	5.0E+00	3.6E+00	Hot cell waste and DU
59	1973 – 1974	1.8 / 18	UL	4.8E+01	5.4E+00	Tritium-contaminated steel, tools, and waste
60	1972 – 1974	0.91 / 8	UL	5.0E+00	3.2E+01	Oil-contaminated with U-235 and Pu-239
61	1973 – 1974	0.91 / 8	UL	5.0E+00	4.4E+00	Beryllium waste, U-238 contaminated metal, and animal tissue
62	1976	0.91 / 8	UL	5.0E+00	3.5E+00	Animal tissue, Pu-238, and P-32
63	1976	0.91 / 8	UL	5.0E+00	2.3E+00	DU and residues
64	1976 – 1977	0.91 / 8	UL	5.0E+00	1.1E+00	Animal wastes and U-235
65	1976 – 1977	0.91 / 8	UL	5.0E+00	3.9E+00	Classified U wastes, targets, and animal tissue
66	1976 – 1979	0.91 / 8	UL	5.0E+00	6.5E-01	Animal tissue
67	1977	0.61 / 8	UL	5.0E+00	1.3E+00	Targets and cell trash
68	1977	0.61 / 8	UL	5.0E+00	9.0E-01	Cell trash and classified notebooks
69	1977	0.61 / 8	UL	5.0E+00	5.7E-01	Parts from recovery
70	1975 – 1976	1.8 / 18	UL	4.8E+01	2.6E+01	Contaminated oil
71	1978	0.91 / 8	UL	5.0E+00	8.8E-01	No description

Source: LANL. 2003. adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
72	1972 – 1973	0.61 / 8	UL	2.2E+00	2.8E+00	Irradiated stainless steel and hot cell waste trash
73	1973	0.61 / 8	UL	2.2E+00	3.4E-01	Hot cell trash
74	1973	0.61 / 8	UL	2.2E+00	9.3E-01	Pu-239 waste
75	1973	0.61 / 8	UL	2.2E+00	9.2E-01	Pu-238 waste and cell trash
76	1973 – 1974	0.61 / 8	UL	2.2E+00	8.1E-01	Hot cell trash
77	1973 – 1974	0.61 / 8	UL	2.2E+00	3.4E-01	Hot cell trash and Pu-239 hot cell trash
78	1974 – 1975	0.61 / 8	UL	2.2E+00	3.9E+01	Cell wastes, reactor wastes, and irradiated box ends
79	1974 – 1975	0.61 / 8	UL	2.2E+00	3.4E-01	Hot cell waste and irradiated metal
80	1975 – 1976	0.61 / 8	UL	2.2E+00	4.2E+01	Sodalime, Ta-182 chips, and animal tissue
81	1976	0.61 / 8	UL	2.2E+00	9.9E-01	Animal tissue
82	1978	0.91 / 8	UL	5.0E+00	5.0E+01	Trash and chemical wastes
83	1978	0.91 / 8	UL	5.0E+00	1.3E+00	Animal tissue and DU
84	1978	0.91 / 8	UL	5.0E+00	3.8E+01	Trash from SRL and cell trash
85	1978	0.91 / 8	UL	5.0E+00	5.1E-01	Neutralized Na Dowanol and cell trash
86	1977	0.91 / 8	UL	5.0E+00	6.2E-01	Spallation products and classified materials
87	1977	0.61 / 8	UL	2.2E+00	5.2E+01	Cell wastes

Source: LANL, 2003, adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
88	1977	0.61 / 8	UL	2.2E+00	5.0E-01	Cell wastes
89	1977 – 1978	0.61 / 8	UL	2.2E+00	8.1E-01	Animal tissue and cell waste
90	1978	0.61 / 8	UL	2.2E+00	4.0E+01	DU and hot cell trash
91	1977 – 1978	0.81 / 15	UL	1.0E+01	1.9E+01	Spallation products, animal waste, cell trash, and trash cans
92	1977 – 1978	0.81 / 15	UL	1.0E+01	2.2E+01	Spallation products and uranyl-nitrate in HNO_3
93	1978 – 1984	0.91 / 15	UL	1.0E+01	7.5E+00	Spallation products, fuel elements, cell waste, and animal tissues
94	1978 – 1984	0.91 / 15	UL	1.0E+01	1.7E+01	Hot cell waste, DU, and control rods
95	1984	0.91 / 15	UL	1.0E+01	4.1E+00	Cell wastes and animal tissues
96	1977 – 1979	1.8 / 15	UL	4.0E+01	6.3E+01	Uranium-contaminated oil, nibbium, zirconium, chlorides, and aluminum shell
97	1978 – 1984	0.91 / 18	UL	1.2E+01	1.9E+01	Uranium chips and turnings, vials, and animal waste
99	1983 – 1984	0.91 / 18	UL	1.2E+01	6.9E+01	Hot cell wastes, animal tissue, and machine parts
100	1983	0.91 / 18	UL	1.2E+01	4.5E+01	Hot cell waste, and target/stinger
101	1980 – 1981	0.91 / 18	UL	1.2E+01	2.5E+00	Spallation products and hot cell waste
102	1982 – 1983	0.91 / 18	UL	1.2E+01	5.2E+00	No description

Source: LANL, 2003, adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
103	1981 – 1982	0.91 / 18	UL	1.2E+01	4.8E+00	Hot cell waste and spent fuel elements
104	1982	0.91 / 18	UL	1.2E+01	4.3E+00	Uranium chips and scrap metal
105	1982 – 1983	0.91 / 18	UL	1.2E+01	5.6E+00	Animal tissue
106	1980 – 1981	0.91 / 18	UL	1.2E+01	2.1E+00	Spallation products and hot cell waste
107	1978 – 1981	0.91 / 18	UL	1.2E+01	1.4E+00	Hot trash, animal tissue, and chemical waste
108	1980 – 1982	0.91 / 18	UL	1.2E+01	6.5E+00	Spallation products, solvent, and animal tissue
109	1980	0.61 / 18	UL	5.3E+00	2.3E+00	Spallation products and trash cans
110	1979	0.91 / 18	UL	1.2E+01	3.6E+00	Spallation products, animal tissue, and mixed combustible trash
111	1979 – 1980	0.61 / 18	UL	5.3E+00	3.8E+00	Cell waste, spallation products, and niobium and tantalum perchloride
112	1978 – 1979	0.91 / 18	UL	1.2E+01	4.2E+00	Classified pieces, animal waste, cell waste, and spallation products
114	1979 – 1982	1.8 / 18	UL	4.8E+01	2.8E+01	Shielding blocks and graphite design assembly
115	1979 – 1982	1.8 / 18	UL	4.8E+01	1.5E+01	Hot trash and tritium scrap
118	1983 – 1984	2.4 / 20	UL	9.3E+01	1.3E+01	Vials
119	1983	2.4 / 19	UL	8.8E+01	1.6E+01	DU chips, hydrocarbons, and HF leach solids
120	1983 – 1984	2.4 / 19	UL	9.0E+01	1.5E+01	Shielding blocks and graphite design assembly

Source: LANL, 2003, adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
121	1984 – 1985	1.2 / 18	UL	2.1E+01	6.9E+00	Animal tissue and cell trash
122	1984 – 1985	1.2 / 18	UL	2.1E+01	7.1E+00	Hot cell waste and waste cans
123	1984	1.8 / 18	UL	4.8E+01	1.5E+01	DU chips and turnings, and firing residue
124	1984 – 1991	1.8 / 20	UL	5.2E+01	1.3E+01	Vials, organics
125	1984	1.8 / 20	UL	5.2E+01	1.7E+01	DU chips and turnings
126	1985 – 1987	1.8 / 20	UL	5.2E+01	2.2E+01	Meson and hot cell waste
127	1985	1.8 / 20	UL	5.2E+01	1.4E+01	DU chips and turnings and U3 08 oil and wax
128	1985 – 1986	1.8 / 20	UL	5.2E+01	9.9E+00	Animal tissue and mustargem
129	1986	0.91 / 20	UL	1.3E+01	3.8E+00	Mixed spallation products
130	1986 – 1987	1.8 / 20	UL	5.2E+01	3.1E+01	DU chips and metal trash
131	1987 – 1995	1.8 / 20	CMP	5.2E+01	1.3E+01	Activated shielding
132	1987 – 1993	1.8 / 20	UL	5.2E+01	1.5E+01	Classified material
133	1986 – 1987	1.2 / 20	UL	2.3E+01	2.2E+00	Spallation products and hot cell waste
134	1986	0.91 / 20	UL	1.3E+01	4.9E+00	Animal tissue
135	1986 – 1987	0.91 / 20	UL	1.3E+01	6.1E+00	Animal tissue
136	1986 – Present [b]	1.8 / 20	UL	5.2E+01	9.3E+00	Low-level tritium; operational as of 2004
137	1987 – Present [b]	1.8 / 20	UL	5.2E+01	1.9E+01	Low-level tritium; operational as of 2004

Source: LANL, 2003, adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
138	1987 – 1989	1.2 / 18	UL	2.1E+01	5.4E+00	Animal tissue
139	1987 – 1988	1.2 / 18	UL	2.1E+01	8.8E+00	Hot cell waste
140	1987 – 1991	1.8 / 19	UL	4.9E+01	2.4E+01	Animal tissue
141	1988 – 1991	1.8 / 18	UL	4.8E+01	9.2E+00	Hot cell waste and reactor parts
142	1991	1.2 / 18	UL	2.1E+01	3.2E+00	Hot cell waste
143	1991 – 1995	1.8 / 19	UL	5.0E+01	9.4E+00	Hot cell waste
144	1995 – 1996	1.8 / 20	UL	5.2E+01	8.8E+00	Animal tissue
147	1991 – Present [b]	1.8 / 20	UL	5.2E+01	9.5E+00	Graphite; operational as of 2004
148	1991 – 1993	1.2 / 20	UL	2.3E+01	7.9E+00	HEPA filter shaft
149	1991 – 1994	1.2 / 20	UL	2.3E+01	9.1E+00	HEPA filter shaft
150	1976 – 1979	1.8 / 18	CMPAC	4.8E+01	1.8E+01	Low-level tritium
151	1979 – 1986	0.91 / 18	CMPAC	1.2E+01	2.0E+01	Low-level tritium
152	1980 – 1983	0.91 / 18	CMPAC	1.2E+01	4.2E+00	Tritium scrap, tubing, and hardware
153	1983 – 1984	0.91 / 18	CMPAC	1.2E+01	3.1E+00	Contaminated pump and equipment
154	1984 – 1986	0.91 / 20	CMPAC	1.3E+01	5.5E+00	High-level tritium, molecular sieves
155	1988 – 1989	0.91 / 20	CMPAC	1.3E+01	3.8E+00	High-level tritium
156	1986 – 1987	0.91 / 14	CMPAC	9.0E+00	1.7E+00	Dry box trash and molecular sieves

Source: LANL, 2003, adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
157	1987 – 1988	0.91 / 14	CMPAC	9.0E+00	2.5E+00	Tritium
158	1989 – 1998	0.61 / 14	CMPAC	4.0E+00	2.2E+00	High-level tritium
159	1989 – Present [b]	0.61 / 14	CMPAC	4.0E+00	3.2E-01	High-level tritium; operational as of 2004
160	1990 – 1993	0.61 / 14	CMPAC	4.0E+00	2.5E+00	High-level tritium
161	1993 – 1994	0.91 / 18	CMPAC	1.2E+01	3.7E+00	High-level tritium
162	1995	0.91 / 18	CMPAC	1.2E+01	1.6E+00	High-level tritium
163	1999	0.91 / 18	CMP	1.2E+01	3.5E+00	High-level tritium
164	1999	0.91 / 18	CMP	1.2E+01	3.4E+00	High-level tritium
165	1999 – Present [b]	0.91 / 18	CMP	1.2E+01	2.7E+00	High-level tritium; operational as of 2004
166	2001 – Present [b]	0.91 / 18	CMP	1.2E+01	2.6E+00	High-level tritium; operational as of 2004
167	2001 – Present [b]	0.91 / 18	CMP	1.2E+01	2.4E+00	High-level tritium; operational as of 2004
168	2001 – Present [b]	0.91 / 18	CMP	1.2E+01	2.4E+00	High-level tritium; operational as of 2004
169	1999 – Present [b]	0.91 / 18	CMP	1.2E+01	1.7E+00	High-level tritium; operational as of 2004
170	2001 – Present [b]	0.91 / 18	CMP	1.2E+01	9.5E-01	High-level tritium; operational as of 2004
171	1995	1.8 / 20	CMPAC	5.2E+01	9.5E+00	Hydrocarbon oil, absorbed, no free liquid; lab trash
172	1995	1.8 / 20	CMPAC	5.2E+01	3.8E+00	Chemical treatment sludge and noncombustibles

Source: LANL, 2003, adapted from Table B-3.

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Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
173	1995	1.8 / 20	CMPAC	5.2E+01	3.7E+00	Contaminated soil, animal tissue, and cement paste
174	1995	1.8 / 20	CMPAC	5.2E+01	6.2E+00	Contaminated soil and chemical treatment sludge
175	1995	1.8 / 20	CMPAC	5.2E+01	6.5E+00	Chemical treatment sludge
176	1995	1.8 / 20	CMPAC	5.2E+01	6.0E+00	Hydrocarbon oil, chemical treatment sludge, and equipment
177	1995	1.8 / 20	CMPAC	5.2E+01	5.2E+00	Chemical treatment sludge
189	1987 – 1988	4.9 / 20	UL	3.7E+02	4.9E+01	LAMPF activated shielding
190	1983 – 1984	4.9 / 20	UL	3.7E+02	3.1E+01	Scrap metal
191	1984 – 1986	4.9 / 20	UL	3.7E+02	3.9E+01	LAMPF scrap metal and graphite target
192	1987 – 1989	4.9 / 20	UL	3.7E+02	4.4E+01	LAMPF scrap metal
196	1989 – 1993	4.9 / 16	UL	3.0E+02	5.8E+01	LAMPF inserts
197	1993 – Present [b]	4.9 / 18	UL	3.4E+02	4.0E+01	Hot cell waste, trash, and trash cans; operational as of 2004
206	1980 – 1981	0.61 / 5	SPI	1.6E+00	4.5E-01	Cell trash and fuel sample
301	1992 – Present [b]	2.4 / 7	CMP	3.1E+01	6.4E-01	LLW irradiation sources; operational as of 2004
307	1992 – 1994	0.61 / 15	UL	4.4E+00	3.4E+00	Control rods
308	1992 – 1994	1.5 / 20	SPI	3.6E+01	2.9E+00	Beryllium shaft

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LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
LAMPF = Los Alamos Meson Physics Facility
PCB = Polychlorinated biphenyl
EBR-II = Experimental Breeder Reactor II
MFP = Mixed fission products
HEPA = High efficiency particulate air
SPI = Steel pipe insert

[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts: LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume; the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
327	2003 – Present [b]	1.2 / 20	SPI	2.3E+01	3.2E+00	Beryllium-contaminated debris and scrap metal; operational as of 2004
329	2003 – Present [b]	1.2 / 20	SPI	2.3E+01	3.7E+00	Lab trash and scrap metal; operational as of 2004
331	2003 – Present [b]	1.2 / 20	SPI	2.3E+01	2.6E+00	Beryllium-contaminated debris, scrap metal, lab trash, and hot cell waste; operational as of 2004
333	2003 – Present [b]	1.2 / 20	SPI	2.3E+01	1.6E+00	Lab trash and molecular sieves; operational as of 2004
335	2003 – Present [b]	1.2 / 20	SPI	2.3E+01	7.5E-01	Molecular sieves; operational as of 2004
339	1997 – Present [b]	1.2 / 20	SPI	2.3E+01	5.4E+00	Lab trash, animal tissue, and radioactive sources; operational as of 2004
341	2003 – Present [b]	1.2 / 20	SPI	2.3E+01	6.2E+00	Beryllium-contaminated debris, scrap metal, and lab trash; operational as of 2004
343	2002 – Present [b]	1.2 / 20	SPI	2.3E+01	5.6E+00	Lab trash, animal tissue, and scrap metal; operational as of 2004
345	2002 – Present [b]	1.2 / 20	SPI	2.3E+01	4.1E+00	Lab trash and animal tissue; operational as of 2004
347	2001 – Present [b]	1.2 / 20	SPI	2.3E+01	3.7E+00	Molecular sieves; operational as of 2004
349	2000 – Present [b]	1.2 / 20	SPI	2.3E+01	5.0E+00	Lab trash, molecular sieves, and scrap metal; operational as of 2004

Source: LANL, 2003, adapted from Table B-3.

UL = Unlined
CMP = Corrugated metal pipe
MAP = Mixed activation products
CMPAC = Corrugated metal pipe, asphalt coated
LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
LAMPF = Los Alamos Meson Physics Facility
PCB = Polychlorinated biphenyl
EBR-II = Experimental Breeder Reactor II
MFP = Mixed fission products
HEPA = High efficiency particulate air
SPI = Steel pipe insert

[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts; LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume; the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
351	1999 – Present [b]	1.2 / 20	SPI	2.3E+01	6.8E+00	Lab trash, molecular sieves, and skull and oxide; operational as of 2004
355	2001 – Present [b]	1.2 / 20	SPI	2.3E+01	4.9E+00	Lab trash, animal tissue, and scrap metal; operational as of 2004
357	1999 – Present [b]	1.2 / 20	SPI	2.3E+01	5.5E+00	Lab trash and radioactive sources; operational as of 2004
360	2003 – Present [b]	1.8 / 19	UL	5.0E+01	1.9E+01	Beryllium-contaminated debris and other building debris; operational as of 2004
361	2003 – Present [b]	1.8 / 19	UL	5.0E+01	6.3E+00	Lab trash and building debris; operational as of 2004
362	2003 – Present [b]	1.8 / 19	UL	5.0E+01	3.3E+00	Lab trash; operational as of 2004
363	2003 – Present [b]	1.8 / 19	UL	5.0E+01	3.1E+00	Lab trash; operational as of 2004
364	2003 – Present [b]	1.8 / 19	UL	5.0E+01	3.2E+00	Lab trash; operational as of 2004
365	2003 – Present [b]	1.8 / 19	UL	5.0E+01	3.1E+00	Lab trash; operational as of 2004
366	2003 – Present [b]	1.8 / 19	UL	5.0E+01	1.3E+00	Beryllium; operational as of 2004
367	2003 – Present [b]	1.8 / 19	UL	5.0E+01	3.1E+00	Lab trash; operational as of 2004
370	1999 – Present [b]	4.9 / 18	UL	3.4E+02	5.0E-01	Scrap metal; operational as of 2004
C1	1980	1.8 / 18	UL	4.8E+01	6.2E+00	PCBs

Source: LANL, 2003, adapted from Table B-3.

UL = Unlined
CMP = Corrugated metal pipe
MAP = Mixed activation products
CMPAC = Corrugated metal pipe, asphalt coated
LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
LAMPF = Los Alamos Meson Physics Facility
PCB = Polychlorinated biphenyl
EBR-II = Experimental Breeder Reactor II
MFP = Mixed fission products
HEPA = High efficiency particulate air
SPI = Steel pipe insert

[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts; LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume; the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

Table 2 (Continued)
Historical Use and General Characteristics of Disposal Shafts at Material Disposal Area G

Shaft No.	Operational Period	Diameter/Depth (m)	Liner	Shaft Volume (m^3)	Waste Volume (m^3) [a]	Waste Description
C2	1981	1.8 / 18	UL	4.8E+01	1.0E+01	PCBs
C3	1981	1.8 / 18	UL	4.8E+01	9.6E+00	PCBs
C4	1981	1.8 / 18	UL	4.8E+01	1.1E+01	PCBs
C5	1981	1.8 / 18	UL	4.8E+01	7.3E+00	PCBs
C6	1981	1.8 / 18	UL	4.8E+01	1.3E+01	PCBs
C7	1981	1.8 / 18	UL	4.8E+01	1.4E+01	PCBs
C8	1981 – 1982	1.8 / 18	UL	4.8E+01	1.4E+01	PCBs
C9	1982 – 1984	1.8 / 18	UL	4.8E+01	1.1E+01	PCBs
C10	1984 – 1985	1.8 / 18	UL	4.8E+01	1.5E+01	PCBs
C11	1985 – 1992	1.8 / 18	UL	4.8E+01	1.4E+01	PCBs
C12	1986 – 1990	1.8 / 18	UL	4.8E+01	1.6E+01	PCBs
C13	1987 – Present [b]	1.8 / 20	CMP	5.2E+01	3.1E+01	PCBs; operational as of 2004
C14	1992 – Present [b]	1.8 / 20	UL	5.2E+01	2.1E+00	PCBs; operational as of 2004

Source: LANL, 2003, adapted from Table B-3.

UL = Unlined
CMP = Corrugated metal pipe
MAP = Mixed activation products
CMPAC = Corrugated metal pipe, asphalt coated
LLW = Low-level waste
DU = Depleted uranium
LAMPRE-II = Los Alamos Molten Plutonium Reactor Experiment II
SRL = Size Reduction Lab
LAMPF = Los Alamos Meson Physics Facility
PCB = Polychlorinated biphenyl
EBR-II = Experimental Breeder Reactor II
MFP = Mixed fission products
HEPA = High efficiency particulate air
SPI = Steel pipe insert

[a] *The listed waste volumes represent the sum of the LLW and transuranic (TRU) waste placed in the shafts; LLW disposal and TRU waste databases were used to estimate post-1970 volumes while pre-1971 volumes were adopted from Rogers (1977). In some case the listed volume exceeds the shaft volume; the sources of these errors were not evident.*

[b] *"Present" indicates early 2004*

The MDA G performance assessment and composite analysis issued in 1997 (Hollis et al., 1997) assumed that the disposal facility would accept LLW through 2044 and undergo final closure during the subsequent two years. Since 1997, the closure schedule for much of MDA G has been accelerated. Current plans call for all existing pits and shafts to be closed by the year 2015; phased closure of the site is expected to begin as early as 2008 (DOE, 2002). Additional LLW disposal capacity will be needed during and following this phased closure. Consequently, plans call for the establishment of new pits and shafts in the Zone 4 expansion area that lies immediately to the west of the current waste disposal site. It is assumed that disposal will continue within this expansion area until 2044.

As mentioned, quantities of TRU waste were retrievably placed in pits 9 and 29, trenches A–D, and several shafts. Analyses have been conducted to determine if the retrieval and subsequent shipment of the waste in these units to WIPP is the best management strategy for this material. While it appears that the majority of the waste will be retrieved, decisions regarding the final destination of this material are expected to be finalized in 2005.

3.0 Methods Used for Inventory Projections

This section describes the methodology used to develop the inventory projections. The methodology discussion is divided into two major parts: determining the inventory for the *historical* waste disposed of at MDA G from 1957 through the end of 2003 (Section 3.1) and determining the inventory for the *future* waste projected to require disposal from 2004 until the closure of MDA G in 2044 (Section 3.2).

3.1 Historical Inventory Projections

The historical inventory, as the term is applied in this report, refers to all waste disposed of at MDA G since the facility opened in 1957 through the end of 2003. Currently, the types and quantities of LLW disposed of at MDA G are recorded on shipment manifests and entered into the LANL LLW disposal database on a per-package basis. Disposal records from 1971 through the present day have been maintained in this database. Compiled information includes the waste form, volume, and total activity of the waste package, and radionuclide activities in the waste. Records for waste disposed of before 1971 were generally maintained in handwritten logbooks; the information recorded in these logbooks tends to be considerably less detailed than the disposal database records.

The records for TRU waste disposed of at MDA G prior to 1971 are also included in the handwritten logbooks. Since 1971, almost all TRU waste generated at the Laboratory has been segregated and placed in retrievable storage, although small quantities of TRU waste were nonretrievably disposed of in pits and shafts through 1979. Since 1971, the types and quantities of TRU waste placed in storage or disposed of have been recorded on shipment manifests and entered into the TRU waste database.

Because records for radioactive waste disposed of prior to 1971 are incomplete, an alternate means of characterizing pre-1971 waste was needed. The pre-1971 portion of the historical inventory was estimated for the 1997 composite analysis (Hollis et al., 1997) through an extrapolation process which assumed that characteristics of waste disposed of from 1971–1977 could be applied to pre-1971 waste. The estimated pit and shaft inventories were adjusted to account for unique or nonroutine disposals that were overlooked by the extrapolation process.

The pre-1971 waste was a significant contributor to the doses projected for the 1997 composite analysis. Consequently, the inventory projections for this period were reexamined with the aim of reducing the uncertainty inherent in these estimates. A comprehensive evaluation of the disposal records maintained from 1957–1970 was conducted, focusing on Am-241 and several isotopes of plutonium, which were the radionuclides that resulted in the greatest potential doses in the 1997 composite analysis. The methods used to conduct this evaluation are summarized below; Pollard and Shuman (1999) provide a complete description of the effort.

The first step in the pre-1971 waste evaluation effort was to identify the types of records available for characterizing the waste. Toward this end, all information available for the January–June 1965 period was assembled and reviewed; the period from which records were reviewed was extended (to provide a larger dataset) for some types of disposal records. Sources of information were evaluated in terms of their relevance to the development of radionuclide-specific inventories and a subset of the sources was identified for inclusion in the comprehensive data evaluation. All pre-1971 data found in the selected sources were extracted and entered into databases; these data were subsequently used to project inventories for 1959–1970, the period during which routine waste was disposed of at MDA G. Section 4.1.1 provides a description of the types of records reviewed and those used to estimate inventories.

A comparison of the extrapolation approach used in the 1997 composite analysis inventory and the inventory estimates developed using data extracted from actual disposal records revealed similarities for some waste streams and significant differences for others. Because of these mixed results, the 1997 extrapolation approach was considered for use in the updated inventory characterization. This approach is described in the following paragraphs.

The extrapolation approach characterizes waste from a post-1971 period (which had more complete disposal records) and applies these characteristics to the pre-1971 material. The first step was to identify the period(s) to be used as the basis for the extrapolation. The selection of these periods for the 1997 composite analysis and the current MDA G inventory update was based on an examination of the LLW and TRU waste disposal databases, combined with additional information about the Laboratory. After suitable extrapolation periods were identified, average annual disposal volumes and activities were calculated for the pits and shafts, and multiplied by the number of years the facility accepted waste for disposal in the respective disposal units. For example, the average annual pit inventories were multiplied by 12 years because the disposal facility began accepting routine contaminated waste on January 2, 1959; only nonroutine waste was disposed of in 1957 and 1958. The average annual disposal quantities disposed of in shafts were multiplied by 5 years, consistent with the fact that these units began accepting waste in April 1966.

The extrapolation approach outlined above is based on the assumption that the waste disposed of during the selected extrapolation periods was similar to the 1959–1970 wastes. While this is generally expected to be the case, some types of wastes generated before and after the end of 1970 were unique to those periods. Laboratory personnel familiar with historical operations at the Laboratory were asked to identify wastes unique to pre-1971 and to the extrapolation periods selected for the pits and shafts. Based on this information, waste that was unique to the 1957–

1970 period was added to the inventories estimated using the extrapolation approach. Conversely, waste that was generated during the extrapolation periods under conditions that did not exist prior to 1971 was removed from the datasets used to estimate the earlier inventories.

The inventory characterization approach used to estimate the 1997 composite analysis inventory was reviewed by J. L. Warren, a former LANL employee, prior to its implementation. Two suggestions for refining the inventory estimates for the pre-1971 disposal shafts emerged from that review (Warren, 1996). First, Warren suggested that the shaft inventory might be better estimated using actual disposal records for 1966–1970 rather than assigning waste properties based on the extrapolation approach. This was recommended because, in general, the pre-1971 shaft disposal records are believed to be relatively complete (in contrast to pit records from the same time period). A second alternative suggested by Warren was to increase the length of the period from which data were drawn to extrapolate shaft waste characteristics. Specifically, Warren was of the opinion that using waste data from 1971–1977 might result in a more accurate estimate of the shaft inventory than limiting data to the 1971–1975 period, which had been chosen as the shaft extrapolation period. Although Warren's recommendations were not adopted for the 1997 performance assessment and composite analysis, their impacts on shaft inventory projections were considered during the current characterization effort.

The MDA G historical waste inventory for 1971–2003 was estimated using the data in both the LANL LLW disposal and TRU waste databases. Most of the inventory for this period was derived from the LLW disposal records. The TRU waste that was nonretrievably disposed of in pits and shafts from 1971–1979 was added to the LLW inventory to determine the total inventory for the period. The TRU waste component includes material that was placed in pits 6–8, 20, and 22, and shafts 17–110. It was assumed that all TRU waste that has been retrievably placed in pits 9 and 29, trenches A–D, and shafts 200–232 and 302–306 will be removed from MDA G and shipped for off-site disposal. Consequently, this waste is not included in the inventory projections.

The physical and chemical forms of the waste disposed of in the pits and shafts play an important role in determining how, and at what magnitude, radionuclides are released to the environment from the disposal units. For example, surface contamination on glass may be quickly rinsed from the waste as water percolates through the disposal units, whereas radionuclides sorbed to soils or concrete may be released gradually over time. Given these potential differences, the various waste streams disposed of at MDA G were categorized or grouped into three predominant waste-forms — surface-contaminated waste, soil, and concrete and sludge (see Table 3). Each waste stream was conservatively assumed to be surface-contaminated waste unless specific knowledge about the waste and its release characteristics allowed it to be assigned to a different waste-form category. Waste streams encompassing a variety of waste matrices were assumed to fall into several different waste forms. For example, waste streams consisting of debris were assumed to include surface-contaminated components, soils, and concrete (see waste codes 36, 69, and 72 in Table 3).

Separate inventory projections were developed for each waste form. These projections included total volumes, total activities, and radionuclide-specific activities and were further divided according to pits and shafts. The historical inventory for each set of units was also divided into pre-1971, 1971 through September 26, 1988, and September 27, 1988 through 2003 time segments. These delineations were made for several reasons. First, maintaining pit inventories separate from shaft inventories allows the disposal units to be represented with greater resolution in the transport models that are used to simulate the performance of the disposal facility. Furthermore, the use of unit-specific inventories provides insight into the relative effectiveness of the two disposal technologies.

Second, separation of the pre-1971 waste from the rest of the historical waste allows consideration of uncertainties associated specifically with projections for this earlier waste (e.g., those introduced by the extrapolation process). Finally, for regulatory purposes, separate pit and shaft inventories were developed for the waste that was disposed of from 1971 through September 26, 1988 and that placed from September 27, 1988 through 2003. The performance assessment addresses waste disposed of after September 26, 1988 while the composite analysis includes all historical (and future) waste. Therefore, to demonstrate compliance with the performance objectives found in DOE Order 435.1, it must be possible to identify wastes disposed of during each period.

Separate inventories were developed for all historical waste pits except pits 1–5. These pits were active prior to 1971, the first year with detailed unit-specific disposal data. Consequently, much of the inventory in these units was estimated using the extrapolation approach described earlier. Given the general nature of this estimation procedure, it was not possible to assign individual inventories to each of these pits. Pit 6 was also active prior to 1971 but the majority of waste placed in this unit appears to have been disposed of after 1970. A post-1970 inventory was developed for this unit using information from the LLW disposal and TRU waste databases. The characteristics of the waste that was disposed of in pit 6 prior to 1971 were estimated using the extrapolation approach and arbitrarily assigned to the material in pits 1–5.

Material types that refer to specific radionuclide compositions have been used in the past to describe the LLW and TRU waste shipped to MDA G for disposal or storage (Table 4). These activity-based radionuclide abundances were used to develop the inventory projections for MDA G. Material type definitions for PU41, U72, GAMMA, GRALPH, GRBETA, and TRU were unavailable at the time the inventory projections were prepared. Consequently, the waste that was characterized using these material types was not included in the inventory projections.

Table 3
Waste-Form Assignments for Waste Streams at Los Alamos National Laboratory

Waste Code	Waste Description	Waste Form		
		Surface-Contaminated Waste	Soil	Concrete and Sludge
0	Chemical wastes	X		
10	Graphite solids	X		
11	Graphite powder	X		
14	Combustible decontamination waste	X		
15	Cellulosics (paper, wood, etc.)	X		
16	Plastics	X		
17	Rubber materials	X		
18	Combustible lab trash (paper, plastic, rubber)	X		
181	Noncombustible lab trash (glass, metal)	X		
19	Combined combustible/noncombustible lab trash	X		
20	Hydrocarbon oil (liquid)	X		
21	Silicon-based oil (liquid)	X		
201	Hydrocarbon oil (absorbed, no free liquid)	X		
211	Silicon-based oil (absorbed, no free liquid)	X		
22	Petroleum-contaminated soil		X	
23	Aqueous solution (absorbed, no free liquid)	X		
24	Cemented/immobilized residues/powders			X
25	Leached process residues	X		
26	Evaporator bottoms/salts	X		
28	Chloride salts	X		
30	PN equipment	X		
31	Non-PN equipment	X		
32	PN oversize equipment	X		
33	Non-PN oversize equipment	X		
35	Combustible building debris	X		
36	Noncombustible building debris [a]	50%	25%	25%
40	Combustible hot cell waste	X		
41	Noncombustible hot cell waste	X		
45	Uranium chips and turnings in diesel fuel	X		
451	Solidified uranium chips and turnings	X		
46	Skull and oxide	X		
47	Slag and porcelain	X		

PN = Property number *PCB = Polychlorinated biphenyl*

[a] *Assumed distribution*

Table 3 (Continued)
Waste Form Assignments for Waste Streams at Los Alamos National Laboratory

Waste Code	Waste Description	Waste Form		
		Surface-Contaminated Waste	Soil	Concrete and Sludge
49	Sanitary sludge			X
50	Metal crucibles, scrap, diesel	X		
51	Precious metals	X		
52	Scrap metal	X		
53	Lead	X		
54	Aerosol cans, punctured/cut gas cylinders	X		
55	Filter media	X		
56	Filter media residue	X		
60	Other combustibles	X		
61	Other noncombustibles	X		
62	Molecular sieves	X		
65	Animal tissue	X		
68	Asbestos	X		
69	Asbestos-contaminated debris [a]	50%	25%	25%
70	Chemical waste	X		
71	Beryllium	X		
72	Beryllium-contaminated debris [a]	50%	25%	25%
73	Scintillation vials	X		
74	Ion exchange resins	X		
75	Chemical treatment sludge			X
76	Cement paste			X
77	PCB-contaminated materials	X		
78	PCB-contaminated equipment	X		
79	PCB-contaminated soil		X	
791	PCB-contaminated concrete			X
80	Irradiation sources	X		
801	Irradiation sources in lead shielding	X		
85	Firing point residues		X	
90	Radioactively contaminated soil		X	
95	Glass	X		
99	Unidentified material	X		

PN = Property number *PCB = Polychlorinated biphenyl*

[a] Assumed distribution

Table 4
Material Type Allocations for the Material Disposal Area G Inventory

Material Type	Isotope	Fractional Abundance [a]
AM44	Am-241	1.0E+00
AM45	Am-243	1.0E+00
BK47	Bk-249	1.0E+00
CF48	Cf-252	1.0E+00
CM46	Cm-246	1.0E+00
D38	U-234	2.9E-01
	U-235	1.3E-02
	U-238	6.9E-01
NP82	Np-237	1.0E+00
PU42	Pu-238	6.2E-02
	Pu-239	3.2E-04
	Pu-240	6.5E-03
	Pu-241	9.3E-01
	Pu-242	2.1E-03
	Pu-244	2.0E-09
PU51	Pu-238	7.0E-03
	Pu-239	4.1E-01
	Pu-240	4.9E-02
	Pu-241	5.4E-01
	Pu-242	4.8E-06
PU52	Pu-238	6.1E-03
	Pu-239	2.1E-01
	Pu-240	4.9E-02
	Pu-241	7.4E-01
	Pu-242	2.8E-06
PU53	Pu-238	1.1E-02
	Pu-239	1.2E-01
	Pu-240	4.2E-02
	Pu-241	8.2E-01
	Pu-242	6.1E-06
PU54	Pu-238	8.5E-03
	Pu-239	5.9E-02
	Pu-240	2.8E-02

[a] *Fractional abundance is given on an activity basis*

Table 4 (Continued)
Material Type Allocations for the Material Disposal Area G Inventory

Material Type	Isotope	Fractional Abundance [a]
PU54 (Cont.)	Pu-241	9.0E-01
	Pu-242	9.4E-06
PU55	Pu-238	8.9E-03
	Pu-239	4.5E-02
	Pu-240	2.9E-02
	Pu-241	9.2E-01
	Pu-242	1.0E-05
PU56	Pu-238	8.0E-03
	Pu-239	3.9E-02
	Pu-240	2.9E-02
	Pu-241	9.3E-01
	Pu-242	1.1E-05
PU57	Pu-238	2.7E-02
	Pu-239	1.7E-02
	Pu-240	1.7E-02
	Pu-241	9.4E-01
	Pu-242	2.4E-05
PU83	Pu-238	9.9E-01
	Pu-239	5.0E-04
	Pu-240	1.9E-04
	Pu-241	1.2E-02
	Pu-242	1.4E-07
TH88	Th-232	1.0E+00
U(DEP)	U-234	2.9E-01
	U-235	1.3E-02
	U-238	6.9E-01
U(NAT)	U-234	4.9E-01
	U-235	2.3E-02
	U-238	4.8E-01
U10	U-238	1.0E+00
U11	U-234	2.2E-01
	U-235	5.2E-03
	U-238	7.7E-01

[a] *Fractional abundance is given on an activity basis.*

Table 4 (Continued)
Material Type Allocations for the Material Disposal Area G Inventory

Material Type	Isotope	Fractional Abundance [a]
U12	U-234	2.7E-01
	U-235	1.0E-02
	U-238	7.2E-01
U13	U-234	2.8E-01
	U-235	1.2E-02
	U-238	7.1E-01
U14	U-234	2.8E-01
	U-235	1.2E-02
	U-238	7.0E-01
U15	U-234	2.9E-01
	U-235	1.3E-02
	U-238	6.9E-01
U16	U-234	3.3E-01
	U-235	1.7E-02
	U-238	6.5E-01
U17	U-234	3.8E-01
	U-235	2.1E-02
	U-238	6.0E-01
U18	U-234	4.1E-01
	U-235	2.4E-02
	U-238	5.6E-01
U21	U-234	4.6E-01
	U-235	2.7E-02
	U-238	5.2E-01
U22	U-234	5.1E-01
	U-235	3.1E-02
	U-236	1.6E-03
	U-238	4.6E-01
U23	U-234	5.7E-01
	U-235	3.5E-02
	U-236	4.1E-03
	U-238	3.9E-01
U24	U-234	6.3E-01
	U-235	3.8E-02

[a] *Fractional abundance is given on an activity basis.*

Table 4 (Continued)
Material Type Allocations for the Material Disposal Area G Inventory

Material Type	Isotope	Fractional Abundance [a]
U24 (Cont.)	U-236	6.1E-03
	U-238	3.3E-01
U25	U-234	6.8E-01
	U-235	4.1E-02
	U-236	7.7E-03
	U-238	2.7E-01
U26	U-234	7.2E-01
	U-235	4.2E-02
	U-236	8.5E-03
	U-238	2.3E-01
U27	U-234	7.3E-01
	U-235	4.3E-02
	U-236	8.9E-03
	U-238	2.2E-01
U28	U-234	7.5E-01
	U-235	4.3E-02
	U-236	9.2E-03
	U-238	2.0E-01
U29	U-234	7.7E-01
	U-235	4.4E-02
	U-236	9.5E-03
	U-238	1.8E-01
U30	U-234	7.8E-01
	U-235	4.4E-02
	U-236	9.7E-03
	U-238	1.6E-01
U31	U-234	8.0E-01
	U-235	4.4E-02
	U-236	1.0E-02
	U-238	1.5E-01
U32	U-234	8.6E-01
	U-235	4.4E-02
	U-236	1.0E-02
	U-238	8.4E-02

[a] *Fractional abundance is given on an activity basis.*

Table 4 (Continued)
Material Type Allocations for the Material Disposal Area G Inventory

Material Type	Isotope	Fractional Abundance [a]
U33	U-234	9.1E-01
	U-235	4.1E-02
	U-236	9.1E-03
	U-238	3.6E-02
U34	U-234	9.4E-01
	U-235	3.7E-02
	U-236	7.5E-03
	U-238	1.5E-02
U35	U-234	9.5E-01
	U-235	3.5E-02
	U-236	6.5E-03
	U-238	8.2E-03
U36	U-234	9.6E-01
	U-235	3.3E-02
	U-236	5.2E-03
	U-238	3.0E-03
U37	U-234	9.6E-01
	U-235	3.1E-02
	U-236	4.3E-03
	U-238	7.0E-04
U38	U-234	9.7E-01
	U-235	3.0E-02
	U-236	4.1E-03
	U-238	2.8E-04
U39	U-234	9.7E-01
	U-235	3.0E-02
	U-236	4.0E-03
	U-238	7.2E-05
U70	U-233	1.0E+00
U81	U-234	5.1E-01
	U-235	2.2E-02
	U-238	4.7E-01

[a] *Fractional abundance is given on an activity basis.*

Active institutional control will be maintained over MDA G for a minimum of 100 years after final closure of the disposal facility. During this period, people will be prevented from intruding onto the site for extended periods of time and steps will be taken to ensure proper facility functioning. The effect of these measures will be to minimize any impacts to human health and the environment from the buried waste during this period.

The radionuclides included in the LLW and TRU waste disposed of at MDA G have radioactive half-lives ranging from seconds to millions of years. Many of the short-lived isotopes will decay to negligible levels by the end of the 100-year institutional control period. Exceptions to this will include radionuclides that are daughters of parents with much longer half-lives; these isotopes will effectively assume the half-lives of their parents.

The MDA G inventory was simplified by eliminating short-lived radionuclides that will decay to negligible levels by the end of the 100-year institutional control period. All radionuclides disposed of in the pits and shafts were reviewed in terms of their modes of decay; radionuclides with half-lives of 5 years or less were generally excluded from the inventory projections. A description of the methods used to eliminate short-lived radionuclides from the inventory is provided in *Attachment I*.

3.2 Future Inventory Projections

The waste that has been or will be disposed of at MDA G between 2004 and the closure of the site includes operational waste and material generated by ER and D&D activities. As with the 1997 performance assessment and composite analysis (Hollis et al., 1997), it was assumed that waste will be disposed of through 2044, at which point the facility will undergo final closure. However, current projections about the types and quantities of waste to be disposed of during the 2004–2044 period differ from the projections made for the 1997 performance assessment and composite analysis.

Current plans call for the closure of the majority of MDA G by the year 2015; a phased closure approach is expected to be implemented starting in 2008 to 2009 (DOE, 2002). Disposal operations at the facility will expand into the area immediately west of the existing pits and shafts, a region referred to in the LANL site-wide environmental impact statement (DOE, 1999b) as the Zone 4 expansion area. At the time this report was written, large-scale disposal operations were expected to begin in 2005. The disposal units in the expansion area will be sized to receive an annual total of 2,850 m^3 (1.0×10^5 ft^3) of waste; this material will include all operational waste generated at the Laboratory and as much ER and D&D waste as can be placed without exceeding the disposal limit. Current plans call for waste generated in excess of the 2,850 m^3/yr (1.0×10^5 ft^3/yr) allotment to be shipped off site for disposal.

The changes in disposal operations discussed above complicate the task of projecting future waste inventories. The greatest uncertainty is in the amount and nature of the ER and D&D waste that will be disposed of at MDA G. To project accurate inventories, the quantities of ER and D&D waste generated annually and the radiological properties of the portion of the waste that will be sent to MDA G for disposal must be known. Estimates of the future annual volumes of ER and D&D waste that will be disposed of are available, but these estimates are outdated and do not reflect the accelerated laboratory cleanup mandated by DOE (2002). Furthermore, the radiological characteristics of the ER and D&D waste or, more specifically, of the portion of this waste that will be disposed of at MDA G, are unknown.

Projections of future operational waste inventories are also subject to uncertainties. Although it may generally be assumed that future operations at the Laboratory will resemble those of the recent past, shifts in operations may occur as the Laboratory's mission evolves in response to changing research needs and levels of funding. Any such changes in future operations will affect the types and quantities of LLW that will require disposal at MDA G.

Given these complexities, it was decided to estimate future pit and shaft inventories using an extrapolation approach, making appropriate adjustments for selected waste streams. This approach is expected to be no more uncertain than any other approach with respect to the ER and D&D waste. Such extrapolation assumes the nature of future operations at the Laboratory will not differ significantly from the period of time represented by the extrapolation dataset. Although this may not be the case, careful monitoring of activities during the disposal receipt reviews conducted under the annual MDA G Performance Assessment and Composite Analysis Maintenance Program will provide opportunities to make any needed adjustments as time passes.

Data drawn from the 1996–2003 period were used to extrapolate the future waste inventories for MDA G. These data were evaluated to identify routine operational waste and material generated by ER and D&D activities at the Laboratory. The distinction between these waste types was made on the basis of the waste codes used in the LLW disposal database. The 11 waste codes or streams listed below were assumed to result largely from cleanup activities; all other waste streams were assumed to be generated by normal LANL operations.

- Petroleum-contaminated soil
- Combustible building debris
- Noncombustible building debris
- Asbestos
- Asbestos-contaminated debris
- Beryllium-contaminated debris
- PCB-contaminated materials

- PCB-contaminated equipment
- PCB-contaminated soil
- PCB-contaminated concrete
- Radioactively contaminated soil

The 1996–2003 operational waste data were used to estimate average annual disposal volumes and activities (total and radionuclide-specific) for the pits and shafts; these averages were multiplied by 41 years to yield separate 2004–2044 operational waste inventories for pits and shafts. The average annual volumes and activities of ER and D&D waste placed in pits and shafts from 1996–2003 were also estimated. These annual averages were assumed to be accurate projections for the ER and D&D waste placed during 2004, the year prior to the implementation of the 2,850 m^3/yr (1.0×10^5 ft^3/yr) disposal limit. Annual volumes for ER and D&D waste to be placed in pits and shafts from 2005–2044 were estimated as the difference between the 2,850 m^3 (1.0×10^5 ft^3) disposal capacity limit and the average annual volumes of operational waste that will be placed in pits and shafts during this period. The activities associated with the pit and shaft ER and D&D waste inventories were calculated as the product of the assumed annual volume and the average radionuclide concentrations in pit and shaft waste.

This extrapolation approach is not expected to adequately characterize three specific waste streams: high-activity tritium waste, treated uranium chips, and low-activity soil disposed of in late 2004. High-activity tritium waste is routinely generated at the Laboratory but has been disposed of on a sporadic or infrequent basis. Starting in the early 1990s, the disposal of this waste was discontinued for several years until the adequacy of its packaging could be evaluated and options for recovering the tritium from this waste were explored. Although the Laboratory initially intended to recover tritium, ultimately the decision was made to dispose of it. In 1999, generators of tritium waste were advised to send their stored tritium waste for disposal.

The decision to forego the tritium recovery option has had a significant impact on the rate at which high-activity tritium waste has been sent to MDA G for disposal. Disposal data for 1999 and 2000 indicate total tritium activities that are 22 to 31 times those in wastes shipped for disposal in 1996, 1997, or 1998. Annual disposal activities have increased significantly since 2000. The majority of these high-activity shipments represent waste that was held for recovery.

Further complicating efforts to project future tritium inventories is the fact that two major tritium facilities at the Laboratory have been or are now being closed. Stabilization and shutdown of the Tritium Systems Test Assembly (TSTA) facility was completed in 2003, while shutdown activities at the Tritium Science and Fabrication Facility (TSFF) were nearing completion in 2004. Laboratory operations that were conducted at these facilities and that are scheduled to continue have been or will be transferred to the Weapons Engineering Tritium Facility (WETF), which is expected to continue operations for the foreseeable future. These changes are expected to impact the quantities of tritium waste that will require future disposal.

The storage of high-activity tritium waste for recovery and changes in tritium operations at the Laboratory limit the usefulness of the 1996–2003 disposal data in terms of extrapolating the future tritium inventory. Consequently, this inventory was projected on the basis of data collected from TA-16 and TA-21 personnel. The TA-16 data were used to project generation rates from continuing operations at the WETF, while the information collected from TA-21 was used to estimate the quantities of tritium waste that will be generated by ongoing cleanup activities at the TSFF. Given that the future tritium inventory was estimated directly, all tritium waste generated by TAs 16 and 21 was excluded from the 1996–2003 dataset used in the extrapolation process.

Uranium chips and turnings are routinely generated by LANL shops, although the rate of generation changes in response to programmatic needs. Once generated, the chips and turnings are sent to MDA G for treatment and disposal. Rates of generation increased in 2003 and may remain elevated for a number of years. At the time of this inventory update, several treated drums of chips and turnings were in storage at MDA G awaiting disposal; other drums were in storage awaiting treatment. Additionally, the possibility exists that drums of chips and turnings might be received from another DOE laboratory for treatment and disposal at MDA G.

The extrapolation approach is not expected to produce accurate estimates for future inventories of uranium chips and turnings because the rates of generation have increased relative to historical rates; the possibility that additional quantities of this waste will be accepted from another DOE laboratory further limits the usefulness of extrapolation. Instead, the future inventory of this waste was projected using estimated rates of generation and information about the drums of treated and untreated waste in storage. In implementing this approach, it was assumed that the waste from the other DOE laboratory will be shipped to the LANL for treatment and disposal at MDA G. Consistent with this approach, all 1996–2003 operational disposal data pertaining to uranium chips and turnings were excluded from the dataset that was used to extrapolate future pit and shaft inventories.

A large volume of soil with low levels of radioactive contamination was being disposed of at MDA G as this report was being finalized. This material was excavated during the construction of the Pump House and Influent Storage Tanks Facility at TA-50. Disposal of this nonroutine waste was expected to be complete by the end of 2004. Data drawn from the LLW disposal database were used to characterize the excavated material that had been disposed of prior to the completion of this report; this same information was used to estimate the radiological characteristics of the small amounts of excavation waste that may yet require disposal before the construction project is complete.

In summary, future inventory projections were developed for surface-contaminated waste, soil, and concrete and sludge; these projections were aggregated by the type of disposal unit (pits and shafts). Short-lived radionuclides were eliminated from the future waste inventories unless they were the daughters of long-lived parents. The projections were made using data extrapolated from disposal records of 1996–2003, with the exceptions of high-activity tritium wastes, uranium chips and turnings, and excavated soil from TA-50. Because of recent and expected changes in the disposal volumes of these three waste types, alternate methods were used to project their future inventories.

4.0 Material Disposal Area G Inventory Projections

This section presents the MDA G inventory projections developed using the methodology discussed in Sections 3.1 and 3.2. Inventory projections for the historical waste, which was disposed of from the beginning of operations at MDA G through 2003, are provided in 4.1. Projected future inventories for waste disposed of from 2004–2044 are presented in Section 4.2. Section 4.3 provides a discussion of the uncertainties associated with the inventory projections. The performance assessment and composite analysis inventories are summarized in Section 4.4.

4.1 Historical Inventory Projections

This section presents the historical MDA G inventory for three waste disposal periods:

- From the start of operations at the disposal facility through 1970
- From the beginning of 1971 through September 26, 1988
- From September 27, 1988 through the end of 2003

Separate inventories were developed for these periods for two reasons. First, as discussed in Section 3.1, the amount of detailed data available for characterizing the historical waste differs for the pre-1971 and post-1970 periods. Maintaining the identities of the pre-1971 and post-1970 inventories permits evaluation of the uncertainties inherent in each inventory. Second, the performance objectives upon which the performance assessment is based are specific to waste that is disposed of after September 26, 1988. Consequently, separate inventories were developed for waste disposed of through September 26, 1988 and waste disposed of after this date to demonstrate compliance with these objectives.

Section 4.1.1 presents the results of the inventory characterization for waste disposed of from the start of operations at MDA G through 1970. Sections 4.1.2 and 4.1.3 present the inventories for 1971 through September 26, 1988 and September 27, 1988 through 2003, respectively.

4.1.1 Pre-1971 Waste Inventory

The development of the pre-1971 pit and shaft inventories was based on information from a variety of sources. The comprehensive evaluation of the 1959–1970 MDA G disposal records conducted by Pollard and Shuman (1999) provided insight into the accuracy of the inventories develop for the 1997 composite analysis (Hollis et al., 1997) and helped identify a suitable approach for conducting this inventory update. The results of the data evaluation are discussed below. Following this discussion, the methods adopted for estimating the pre-1971 pit and shaft inventories for the current inventory update are described and the results presented.

4.1.1.1 Historical Disposal Data Evaluation

The pre-1971 data evaluation focused on the radionuclides that made the greatest contributions to the doses projected for the 1997 composite analysis: Am-241 and several isotopes of plutonium. A summary of the results of the 1997 analysis is provided below. Pollard and Shuman (1999) provide a detailed description of the 1997 evaluation.

A review of the 1959–1970 disposal records for MDA G revealed the following sources of information that documented the waste disposed of at the facility:

- Handwritten, bound logbooks with detailed entries describing the burial of each waste shipment
- Handwritten spreadsheets that list LANL-wide radioactive waste disposals during the 1960s
- Disposal memoranda that summarize radioactive waste disposals at the Laboratory
- Sludge disposal records that document the disposal of sludge between 1960 and the mid-1970s
- Miscellaneous disposal records

The information in the bound logbooks includes the disposal date for each waste shipment, the location of the waste in the disposal pits (i.e., pit, layer, and post number), the volume of waste, the type of packaging, the LANL waste generator, and a physical description of the waste. Neither radionuclide identities nor quantities are provided for any shipments. Tables included in the logbooks summarize routine LANL waste shipments disposed of at MDA G. These tables list the number of plastic bags, cardboard boxes, and drums that were disposed of and the disposal locations, but do not provide any information about the radionuclide contents of these packages.

The handwritten spreadsheets were developed by the Laboratory in response to a 1960 Atomic Energy Commission request to report radioactive waste disposals at each federal facility in the U.S. (Johnson, 1960). These spreadsheets provide the dates of disposal, waste generators, physical descriptions of the waste, types and numbers of packages, and waste volumes; the need for shielding of the waste was also specified. The identities of specific radionuclides and activity estimates are provided for some of the waste shipments. The radioactivity level for each shipment is given as low (up to 350 Ci/m^3 [10 Ci/ft^3]), intermediate (350 to 3.5×10^4 Ci/m^3 [10 to 1,000 Ci/ft^3]), or high (greater than 3.5×10^4 Ci/m^3 [1,000 Ci/ft^3]).

Disposal memoranda authored by Dean Meyer, H-1 Group Leader, summarize radioactive waste disposals at the Laboratory from 1960–1968 (Meyer, 1960). It appears these memoranda were developed from the handwritten spreadsheets, as they include all radionuclide-specific information from those spreadsheets. Neither the handwritten spreadsheets nor the memoranda specify where the waste shipments were disposed of at the Laboratory. Three radioactive waste disposal sites were used to dispose of waste during the 1959–1969 period addressed by the spreadsheets and memoranda: MDAs C, G, and T.

The sludge disposal records describe waste disposed of from October 1960 through the mid-1970s and include information on the waste generators, physical forms, and radionuclide contents. Starting in July 1968, the records also specify disposal location (i.e., MDA G or MDA T). The miscellaneous disposal records include a variety of documents found in the course of searching the waste records (e.g., Enders, 1969 and 1970; Warren, 1980).

The various sources of information about the pre-1971 waste were reviewed in terms of their relevance to the development of radionuclide-specific inventories. Based on this review, it was decided that the disposal memoranda, sludge disposal records, and several of the miscellaneous records provided the most value. The logbook information was of marginal use in the development of inventory estimates because of the lack of information about specific radionuclides and because data from the logbooks were also available in Meyer's disposal memoranda. The handwritten spreadsheets and the disposal memoranda contain much duplicate information; it was concluded that the disposal memoranda sufficiently summarized the relevant disposal data. More detailed information about waste volumes and generators was provided in the spreadsheets, but this information was not needed to develop estimates of radionuclide-specific inventories.

All of the pre-1971 disposal memoranda written by Meyer were located and reviewed, and the data contained in these memoranda were tabulated. These memoranda provide detailed information for mid-1960 through December 1961 and for July 1964 through December 1968. No data were found in the Meyer disposal memoranda for 1959, the first half of 1960, January 1962 through June 1964, 1969, or 1970. A memorandum from Enders (1970) provides information about the annual volumes of waste that were shipped for disposal prior to 1970.

As discussed, in most cases the disposal memoranda do not specify the waste disposal locations. Consequently, the waste documented in these memoranda was assigned to specific MDAs using several assumptions. First, it was assumed that all large volumes of low-activity waste listed in the memoranda were disposed of in the pits at MDA G. This assumption was adopted because solid waste disposal operations at MDA C were slowing down in the early 1960s, while MDA G was receiving more and more of this waste. The waste disposed of at the third disposal site, MDA T, was primarily liquid waste. Comparisons of the MDA C shaft disposal records and the memoranda data indicate that most high-activity, low-volume waste was disposed of at MDA C through 1966. Three waste shipments were reported to have been disposed of at MDA C in 1967, but it was not possible to clearly identify these shipments. Therefore, it was assumed that all low-volume, high-activity waste disposed of from 1967–1970 was placed in the shafts at MDA G.

Table 5 summarizes the total waste volumes and activities that were disposed of at MDA G based on the disposal memoranda. The three identified categories of waste are tritium-contaminated waste, waste contaminated with fission products, and all other waste. The third category of waste includes material contaminated with plutonium and Pu-equivalents and is referred to as Pu-equivalent waste in the following discussion. The term Pu-equivalent refers to various alpha-emitting radionuclides such as isotopes of plutonium and Am-241. The Pu-equivalent waste includes sludge that was disposed of during the 1960s; sludge accounts for approximately 3,000 m^3 (1.1×10^5 ft^3) and 1,500 Ci of the totals listed in Table 5 for Pu-equivalent waste.

Table 5
Waste Disposal Volume and Activity Based on Disposal Memoranda

Waste Type	Total Volume (m^3)	Total Activity (Ci)
Tritium-Contaminated Waste	5.1E–01	4.3E+04
Fission-Product Waste	9.6E–01	3.5E+02
Pu-Equivalent Waste	4.0E+04	1.7E+03
Total	4.0E+04	4.5E+04

Source: Meyer, 1960

All sludge disposal records for the pre-1971 period were located and the data contained therein tabulated. Records began in October 1960 and extended into the mid 1970s; no records were found for 1963 or 1970. As stated earlier, the records included the disposal location starting in mid-1968. It was assumed that all waste disposed of prior to this time was sent to MDA G. Waste disposed of at TA-21 (MDA T) was excluded from the data evaluation.

The sludge disposal record evaluation indicates that more than 15,000 drums, with capacities of 0.11 and 0.21 m^3 (30 and 55 gal) were disposed of at MDA G. This amounts to approximately 2,000 m^3 (7.1×10^4 ft^3) of waste. The records provide radionuclide contents in terms of mass; the masses of Am-241, Pu-239, and Pu-equivalents in the waste are 470, 530, and 2.6×10^4 g (1.0, 1.2, and 57 lb), respectively. Converting these masses to activities yields an Am-241 activity of 1,600 Ci, Pu-239 activity of 33 Ci, and Pu-equivalents activity of 160 Ci; the specific activity used to convert the Pu-equivalents mass to activity was 0.062 Ci/g (1.4×10^{-4} Ci/lb) as reported in Enders (1969).

The mass of Pu-equivalents listed in the sludge disposal records includes the Am-241 and Pu-239 masses that were listed separately as well as any Pu-238 and U-235 present in the waste. The total mass of Pu-238 and U-235 may be estimated by taking the difference between the

Pu-equivalent mass and the sum of the Am-241 and Pu-239 masses; the result is 2.5×10^4 g (55 lb). Note that this method does not work for determining activities, as the sum of the Am-241 and Pu-239 activities is greater than the total activity calculated for the Pu-equivalents.

In general, the quantities of sludge estimated by the disposal memoranda and the sludge disposal records concur. The disposal memoranda indicate approximately 3,000 m^3 (1.1×10^5 ft^3) of this waste, while the sludge disposal records indicate 2,000 m^3 (7.1×10^4 ft^3) of material. The Pu-equivalent mass of 2.5×10^4 g (55 lb) listed in the disposal memoranda is in close agreement with the mass of 2.6×10^4 g (57 lb) listed in the sludge disposal records.

A number of miscellaneous waste records that were found in the course of searching the pre-1971 MDA G disposal records contain information relevant to the inventory characterization effort. As discussed, an office memorandum from Enders (Enders, 1970) lists the annual volumes of radioactive waste disposed of at the Laboratory; data for the 1959–1969 period are summarized in Table 6. A spreadsheet with total Laboratory disposal volumes and activities for 1944–1978 was found, though there was no reference for this information. The information contained in this spreadsheet for the 1959-1970 period is summarized in Table 7. The volumes listed in Tables 6 and 7 generally fall within 5 percent of one another.

Table 6
Annual Los Alamos National Laboratory Radioactive Waste Disposal Volume, 1959–1969

Year	Disposal Volume (m^3)
1959	3.7E+03
1960	4.4E+03
1961	5.5E+03
1962	5.5E+03
1963	6.0E+03
1964	7.7E+03
1965	5.0E+03
1966	6.3E+03
1967	6.8E+03
1968	6.3E+03
1969	5.3E+03
Total	6.3E+04

Source: Enders, 1970

Table 7
Annual Los Alamos National Laboratory Radioactive Waste Stream Volume and Activity, 1959–1970

Waste Stream	Waste Disposal by Year											
	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Volume (m³)												
Stored/Buried TRU Waste (> 10 nCi/g)	2.0E+02	3.4E+02	3.6E+02	3.5E+02	3.9E+02	4.1E+02	4.0E+02	5.0E+02	5.4E+02	6.6E+02	5.6E+02	6.7E+02
U/Th Waste	1.3E+03	1.4E+03	1.4E+03	1.4E+03	1.6E+03	4.4E+03	1.6E+03	2.0E+03	2.2E+03	1.9E+03	1.6E+03	1.9E+03
Fission Products	1.0E+01	1.0E+01	1.0E+03	1.0E+03	1.0E+03	1.0E+01	1.0E+01	1.5E+01	1.5E+01	1.5E+01	1.0E+01	1.5E+01
Induced Activity	1.5E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	2.5E+01	3.0E+01	2.5E+01	2.0E+01	2.5E+01
Tritium Waste	4.0E+01	5.0E+01	5.0E+01	5.0E+01	5.5E+01	6.0E+01	6.0E+01	7.0E+01	8.0E+01	7.0E+01	6.0E+01	7.5E+01
Beta/Gamma Emitters in TRU Waste	---	---	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00
Buried TRU Waste (< 10 nCi/g)	2.4E+03	2.7E+03	2.9E+03	2.8E+03	3.2E+03	3.3E+03	3.2E+03	4.0E+03	4.3E+03	3.9E+03	3.3E+03	4.0E+03
Total	4.0E+03	4.5E+03	5.8E+03	5.7E+03	6.2E+03	8.3E+03	5.3E+03	6.6E+03	7.1E+03	6.6E+03	5.6E+03	6.7E+03
Activity (Ci)												
Stored/Buried TRU Waste (> 10 nCi/g)	1.0E+02	2.0E+02	2.0E+02	2.0E+02	2.0E+02	2.0E+02	2.0E+02	2.0E+02	2.0E+02	3.0E+02	4.5E+02	6.0E+02
U/Th Waste	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00	2.8E+00
Fission Products	3.0E+02	3.0E+02	1.9E+03	1.9E+03	1.9E+03	3.0E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02
Induced Activity	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02
Tritium Waste	4.0E+02	6.6E+02	8.5E+01	1.0E+00	3.0E+01	1.8E+03	5.9E+02	5.1E+04	6.3E+03	2.0E+04	3.0E+04	3.4E+04
Beta/Gamma Emitters in TRU Waste	---	---	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02	1.0E+02
Buried TRU Waste (< 10 nCi/g)	7.0E+00	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01	1.0E+01
Total	9.6E+02	1.3E+03	2.4E+03	2.4E+03	2.4E+03	2.6E+03	1.3E+03	5.2E+04	7.0E+03	2.0E+04	3.1E+04	3.5E+04

TRU = Transuranic *--- = Not applicable*

Various MDA G inventory estimates were found during the record search. Unreferenced handwritten calculations dated 1963 through December 22, 1969 indicate a total of 860 and 7,300 g (1.9 and 16 lb) of Pu-239 and U-35, respectively. A draft report entitled "Area G" that describes facility operations from the initial area survey in 1956 through 1972 was also found. The report discusses inventory estimates prepared by Wilbur Workman in 1970 and Wheeler (1984); Table 8 summarizes these data. Another estimate of the MDA G inventory is provided in Rogers (1977); the Rogers information is reproduced in Table 9. Finally, Warren (1980) provides quantities of selected radionuclides that were disposed of at the Laboratory through 1978; these data include waste placed in MDAs B, C, G, and T. The information pertinent to waste disposal at MDA G is summarized in Table 10.

Table 8
Material Disposal Area G Inventory Estimates Developed by Workman and Wheeler

Radionuclide / Constituent	Workman Inventory [a] (g)	Wheeler Inventory (Ci) [b]	
		Pits	Shafts
Am-241	---	2.1E+03	---
Co-60	---	---	2.3E+02
Cs-137	---	---	6.0E+00
D-38	2.3E+07	---	---
Fission Products	---	---	7.7E+01
H-3	< 1.0E+01 [c]	---	7.8E+04 [d]
Induced Activity	---	---	2.5E+03
Na-22	---	---	4.6E+01
Pu-238	2.0E-01	1.5E+01	---
Pu-239	1.1E+03	3.3E+02	---
Sr-90/Y-90	---	4.0E+03	7.5E+02
U-233	---	---	5.0E+00
U-235	9.0E+03	---	---
U [e]	---	4.8E+01	---

--- = Not listed in the inventory

[a] Inventory as of December 18, 1970

[b] Listed activities are decay corrected to December 31, 1972

[c] Total inventory for Material Disposal Areas C and G

[d] The tritium inventory was listed as 9.8 × 10[4] Ci in the report titled "Area G"; an office memorandum later issued by Wheeler (1974) corrected it to the value listed here.

[e] Includes U-234, U-235, U-236, and U-238

Table 9
Estimated Radionuclide Inventory for Material Disposal Area G Pits and Shafts, January 1976

Radionuclide or Constituent	Inventory (Ci) [a]	
	Pits (1959–1975)	Shafts (1965–1975)
H-3	---	9.2E+04
Na-22	---	2.0E+01
Co-60	---	1.5E+02
Sr-90/Y-90	2.8E+03	2.8E+02
Cs-137	---	6.0E+00
U-233	---	5.0E+00
U [b]	5.4E+01	< 1.0E+00
Pu-238	4.4E+01	4.0E+00
Pu-239 [c]	3.7E+02	4.6E+01
Am-241	2.1E+03	---
Fission Products	---	2.0E+02
Induced Activity	---	6.6E+02

Source: Rogers, 1977

--- = Not listed in the inventory

[a] Listed activities are decay corrected to January 1976.

[b] Includes U-234, U-235, U-236, and U-238

[c] Mostly weapons-grade Pu (94 wt. % Pu-239, 6 wt. % Pu-240); curie value based upon 0.072 Ci (alpha)/g

Table 10
Summary of Material Disposal Area G Disposal Data Provided by Warren (1980)

Disposal Date	Disposal Area	Disposal Unit	Mass (g)				Notes
			Pu	Am-241	U-233	Other	
1951–1963	MDA C, G	Pits	NA	NA	NA	NA	Sludges in 0.21-m^3 drums; generated by the TA-45 treatment plant
1952–1967	MDA C, G	Pits	3.4E+02	---	---	5.8E+02 (equivalent Pu) [a]	Over 3,000 0.21-m^3 drums of weapons-grade Pu disposed of as sludge; generated by the TA-21 treatment plant.
1959–1968	MDA C, G	Pits	7.4E+02	6.6E+02	6.5E+02	---	Approximately 11,800 0.21-m^3 drums of weapons-grade material disposed of as cement paste.
1960	MDA G	Pit 1	6.0E+02	---	---	---	Approximately 30 to 40 0.11-m^3 drums containing sand from TA-21 decontamination activities.
1963–1971	MDA C, G	Pits	NA	NA	NA	NA	Sludge in 0.21-m^3 drums
1967–1978	MDA G	Shafts	2.1E+03	---	---	Additional Pu, U, and MFP	Recorded values for all waste disposed of in shafts; primarily hot cell waste.
1972–1978	MDA G	Pits 7, 8, 12, 13, 17, 18, 20, and 22	1.3E+02	---	---	Additional Pu, U, MFP, MAP, and H-3	

Source: Warren, 1980

MDA = Material Disposal Area | *NA = No radionuclide content data provided* | *--- = Not listed in the inventory*

MFP = Mixed-fission products | *MAP = Mixed-activation products*

[a] *This waste has a specific activity of 0.073 Ci/g*

The disposal memoranda, sludge disposal records, and miscellaneous records were used to estimate radiological inventories for the waste disposed of at MDA G prior to 1971. As discussed, the disposal memoranda that were found during the investigation did not include detailed data for waste disposed of in 1959, the first half of 1960, January 1962 through June 1964, 1969, and 1970. The properties of the waste disposed of during the periods for which limited information was available were estimated through extrapolation. For example, late 1960 and 1961 waste data were used to estimate the characteristics of the waste disposed of during 1959 and the first half of 1960. The properties of the waste disposed of between January 1962 and June 1964 were estimated using disposal data for 1961 and from July 1964 to December 1965; waste data from mid-1968 to 1969 were used to characterize the waste disposed of in 1970. The projections developed using the disposal memoranda are summarized in Table 11.

Table 11
Pre-1971 Inventory Projections for Material Disposal Area G
Based on Disposal Memoranda

Waste Stream	Volume (m^3)	Activity (Ci)
Pu-Equivalent Waste	5.4E+04	2.7E+03
Sludge [a]	4.8E+03	2.4E+03
All Waste [b]	5.4E+04	5.6E+04

Source: Meyer, 1960

[a] Sludge waste is a subset of the Pu-equivalent waste.

[b] All waste includes the Pu-equivalent waste, tritium waste, and fission products.

Sludge disposal records could not be found for 1959 through September 1960, 1963, and 1970. The characteristics of the waste disposed of during the first of these periods were extrapolated from waste data for October 1960 through December 1961, while the properties of the 1963 waste were estimated using 1962 and 1964 disposal records. Sludge disposal data for waste disposed of between July 1968 and December 1969 were used to estimate the characteristics of the 1970 waste; this period excludes waste that was generated and disposed of at TA-21 (MDA T) starting in mid-1968. These calculations yielded a total waste volume of 2,800 m^3 (9.9×10^4 ft^3); activities associated with the waste include 1,800, 40, and 2,300 Ci of Am-241, Pu-239, and Pu-equivalents, respectively.

The handwritten calculations for the 1963 through December 22, 1969 period were used to estimate total inventories of Pu-239 and U-235. These calculations indicate that 53 Ci of Pu-239 were disposed of at MDA G over this period; if similar generation rates are assumed for the missing portions of the 1959-1970 period, a total inventory of 91 Ci is estimated for all waste emplaced at MDA G. In a similar fashion, the handwritten calculations were used to obtain a total U-235 inventory of 0.027 Ci for the 1959-1970 timeframe.

The inventory projections developed using the disposal memoranda, sludge disposal records, and miscellaneous records were compared to the inventory projections developed for the 1997 composite analysis (Hollis et al., 1997). Table 12 compares the total volume and activity projections developed using the disposal memoranda and the two sets of LANL-wide disposal data (Tables 6 and 7) to the composite analysis inventory. The MDA G disposal volume projected using the MDA G data from the 1960–1969 Meyer memoranda is consistent with the volume projected for the 1997 composite analysis. Both of these estimates are less than the LANL-wide estimates; this is logical due to the fact that radioactive waste was being disposed of at facilities other than MDA G. The total activity projected using the MDA G disposal memoranda data is in close agreement with the activity estimated for the composite analysis. The LANL-wide disposal activity is about three times greater than the MDA G total, reflective of the fact that low-volume, high-activity waste was disposed of at other facilities prior to 1967.

Table 12
Comparison of Pre-1971 Inventory Projections Based on Disposal Memoranda and Laboratory-Wide Disposal Data with the 1997 Composite Analysis Inventory

Source of Inventory Projections	Volume (m^3)	Activity (Ci)
Disposal Memoranda (Meyer, 1960)	5.4E+04	5.6E+04
LANL Annual Disposal Data (Enders, 1970)	6.3E+04 [a]	---
LANL-Wide Spreadsheet Data	7.2E+04	1.6E+05
1997 Composite Analysis (Hollis et al., 1997)	5.6E+04 [b]	5.5E+04 [b]

MDA = Material Disposal Area LANL = Los Alamos National Laboratory --- = Data source did not include waste activity

[a] Total excludes waste disposed of in 1970. [b] Entries represent the sum of the projected pit and shaft inventories.

The volumes and activities of Am-241 and plutonium-contaminated waste projected using the disposal memoranda (Meyer, 1960) and the sludge disposal records were compared to the 1997 composite analysis estimates for this waste. The results of this comparison are summarized in Table 13. The Pu-equivalent waste shown in this table includes all material containing plutonium and other alpha-emitting radionuclides; the sludge waste information from the disposal memoranda is a subset of the Pu-equivalent material. The composite analysis waste projections are divided into three waste streams.

A comparison of the waste projections shown in Table 13 is complicated by the fact that a large portion of the surface-contaminated waste included in the 1997 composite analysis is expected to be free of any alpha contamination. Perhaps the most reliable comparison involves the sludge data from the disposal memoranda, the totals developed from the sludge disposal records, and the concrete and sludge inventory estimated for the composite analysis. These data are expected to generally represent the same waste and, as such, provide three estimates of the volumes and activities of sludge disposed of at MDA G prior to 1971. As shown in Table 13, the composite analysis volume projection is 1.5 to 2.6 times greater than the volume projections developed using the disposal memoranda and sludge disposal records. The projected activities for all estimates, however, fall within 20 percent of one another. In terms of nonsludge waste, the composite analysis inventory includes a large Pu-equivalent component associated with the surface-contaminated waste. The total activity of this waste is significantly greater than the activities projected using the historical waste disposal records.

Table 13
Comparison of Pu-Equivalent Waste Inventories, 1959–1970

Source of Inventory Projections	Volume (m^3)	Activity (Ci)
Disposal Memoranda (Meyer, 1960)		
Pu-Equivalent Waste	5.4E+04	2.7E+03
Sludge Waste	4.8E+03	2.4E+03
Sludge Disposal Records	2.8E+03	2.3E+03
Composite Analysis Projections (Hollis et al., 1997)		
Surface-Contaminated Waste	4.2E+04 [a]	1.5E+04 [b]
Soil	6.1E+03 [a]	3.9E+01 [b]
Concrete and Sludge	7.5E+03 [a]	2.8E+03 [b]

[a] *The quantities of waste contaminated with Am-241 and plutonium could not be separated from waste without these radionuclides. Thus, listed volumes represent all waste projected for a waste stream; the entries represent the sum of pit and shaft inventories.*

[b] *The listed activities represent the sum of the activities of Am-241 and isotopes of plutonium and uranium; entries represent the sum of pit and shaft inventories.*

Historical disposal records were used to estimate radionuclide-specific inventories that were subsequently compared to the activities developed for the 1997 composite analysis. The development of these inventories from historical data was complicated by data availability issues. Pu-equivalent, Pu-239, and Am-241 inventories were provided for the sludge waste; however, the other waste streams had only Pu-equivalent inventories. No detailed information about Pu-238, Pu-240, or Pu-241 inventories was found in the historical data.

The key to estimating radionuclide-specific activities lies in the ability to accurately allocate the Pu-equivalent inventories. Information to perform this allocation was found in the course of the data evaluation. Enders (1969) provides a specific activity of 0.062 Ci/g (28 Ci/lb) for Pu-equivalent waste. A note found in the miscellaneous records indicates that activities for

Pu-238 and Pu-239 occur in a ratio of about 9:1. Finally, the LANL sludge disposal records indicate that the main contributors to Pu-equivalent activities are Pu-238, Pu-239, Am-241, and U-235.

The information cited above was used in a three-step process to estimate radionuclide-specific activities for the waste included in the sludge disposal records. First, the total masses of Am-241 and Pu-239 in the waste were converted to activities using the specific activities for the two isotopes. Second, the activity of Pu-238 in the waste was estimated by multiplying the Pu-239 activity by 9, consistent with the 9:1 activity ratio discussed above. Finally, the mass of Pu-equivalent not accounted for by the Am-241, Pu-238, and Pu-239 assignments was assumed to be U-235; the specific activity of U-235 was used to convert that mass to an activity. Although other alpha-emitting radionuclides may have been present in the waste disposed of during this period, they were assumed to have made negligible contributions to the total mass.

Data from Warren (1980), summarized in Table 10, were also used to develop radionuclide-specific inventories for the sludge. In developing these estimates, it was assumed that 1,500 of the 0.21-m^3 (55-gal) drums of sludge disposed of from 1952–1967 were buried at MDA G; the other 1,500 drums were assumed to have been sent to MDA C. It was also assumed that all 11,800 of the 0.21-m^3 (55-gal) drums disposed of from 1959–1968 went to MDA G. The sand disposed of in 1960 and the hot cell waste were not included in the sludge waste inventory calculations.

Based on the preceding assumptions, it was estimated that the sludge disposed of at MDA G prior to 1971 contained 910 g (2 lb) of plutonium, 660 g (1.5 lb) of Am-241, and 290 g (0.64 lb) of Pu-equivalents. It appears that the majority of the plutonium in the waste is Pu-239. The sludge waste disposed of between 1952 and 1967 and the cement paste buried between 1959 and 1968 is weapons-grade material (Warren, 1980); the specific activity given for the 1952-1967 waste is 0.73 Ci/g (330 Ci/lb), which is similar to the specific activity of Pu-239 (i.e., 0.62 Ci/g [280 Ci/lb]). Additionally, Warren (1980) indicates that very little Pu-238 was disposed of at MDA G prior to 1979. If we assume that all of the plutonium is, indeed, Pu-239, then the 910 g (2 lb) represents an activity of 58 Ci; the 660 g (1.5 lb) of Am-241 corresponds to an activity of about 2.1×10^4 Ci.

The 290 g (0.64 lb) of Pu-equivalents included in the Warren data (1980) was converted to radionuclide-specific activities using the same three-step process outlined for the sludge disposal records. Using this approach, 0.1, 1.7, 1.4, and 96.8 percent of the total mass of Pu-equivalents in the sludge is Pu-238, Pu-239, Am-241, and U-235, respectively. Applying these percentages to the 290 g (0.64 lb) of Pu-equivalents listed in Warren and converting the masses to activities yields 4.5, 0.3, 14, and 0.006 Ci of Pu-238, Pu-239, Am-241, and U-235, respectively.

The radionuclide-specific inventories estimated from various sources for the sludge waste are summarized in Table 14. The radionuclide-specific activities estimated using the sludge disposal records, the handwritten spreadsheet calculations, and the Warren data (1980) generally agree with the 1997 composite analysis inventory estimates. The composite analysis inventory for Pu-239 is similar to estimates based on the Warren data, handwritten calculations, and Workman data, while the Am-241 inventory estimates are similar across the board. The similarity between the 1997 composite analysis estimates and those based on the Warren data is expected because data from Warren (1980) formed the basis for supplementing the composite analysis inventory to account for waste that was not captured by the extrapolation process. The majority of the Pu-238 that is included in the composite analysis inventory resulted from the extrapolation process and, as a result, differs markedly from the activity estimated for this radionuclide using the Warren data. The Pu-238 activity projection developed using the sludge disposal data is most similar to the composite analysis inventory for this radionuclide, although the two estimates still differ by approximately 200 Ci.

Table 14
Pre-1971 Radionuclide-Specific Inventories Projected for Sludge

Source of Inventory Projections	Activity (Ci)				
	Pu-equiv.	Pu-238	Pu-239	Am-241	U-235
Sludge disposal records	2.3E+03	3.6E+02	4.0E+01	1.8E+03	7.7E-02
Miscellaneous records	---	---	---	---	---
Warren (1980)	2.2E+03 [a]	4.5E+00	5.8E+01	2.1E+03	6.0E-03
Handwritten Spreadsheet Calculations [b]	---	---	9.1E+01	---	2.7E-02
Workman [b]	---	3.5E+00	6.7E+01	---	1.9E-02
Wheeler [b] (1974)	---	1.5E+01	3.3E+02	2.1E+03	---
Rogers (1977)	---	4.8E+01	4.2E+02	2.1E+03	---
Composite Analysis (Hollis et al., 1997)	2.8E+03 [c, d]	5.7E+02 [c]	8.0E+01 [c]	2.2E+03 [c]	3.5E-03 [c]

--- = None

[a] Estimated as the sum of the radionuclide-specific activities

[b] Listed activities are for all waste, not just sludge

[c] Entries represent the concrete and sludge inventory disposed of in the pits

[d] Pu-equivalent activity was not calculated for the composite analysis; it is estimated here as the sum of the activities of Am-241 and isotopes of plutonium and uranium.

Caution needs to be exercised when interpreting the inventory projections provided in Table 14. As pointed out, the handwritten spreadsheet calculations, the Workman and Wheeler data, and the estimates from the Rogers report include all waste, not just the sludge component.

Furthermore, although the Workman data generally coincide with the pre-1971 period of interest, the Wheeler data represent inventories through much of 1972 and the Rogers data address waste disposed of through 1975. Finally, the Wheeler and Rogers data are decay corrected whereas other activities included in the table are not.

As discussed, the inventory developed for the 1997 composite analysis includes large inventories of plutonium-contaminated waste other than sludge. Information about radionuclide activities in nonsludge waste is scarce in the historical disposal records; the historical information that was found is compared to the composite analysis inventory in Table 15. Sources of historical data used in this analysis include the disposal memoranda (Meyer, 1960) for nonsludge waste, the handwritten spreadsheet calculations, and the Workman and Wheeler (1974) data. The disposal memoranda data included in Table 15 represent the Pu-equivalent data found in these records minus the portion of the waste represented by sludge. The handwritten calculations, Workman data, and Wheeler data address all waste disposed of at MDA G, including sludge. The composite analysis inventories are provided for two nonsludge waste streams (i.e., surface-contaminated waste and soil).

It is apparent from Table 15 that the different sources of information do not agree with respect to the nonsludge radionuclide-specific inventories. Using Pu-equivalent activities as a guide, the total activity represented by the composite analysis inventory (Hollis et al., 1997) is about 50 times greater than the total activity estimated from the disposal memoranda. Although the disposal memoranda data have not been allocated to individual radionuclides, it is clear that the isotope-specific activities listed for the composite analysis will be much greater than those that might be estimated from the disposal records. The Pu-238 inventories estimated by Workman and Wheeler are less than 1 percent of the composite analysis inventory for this isotope; Pu-239 inventories estimated using the historical information are 4 to 18 percent of the composite analysis inventory.

The pre-1971 disposal data evaluation effort showed that portions of the 1997 composite analysis inventory are in reasonable agreement with available historical data, while other portions are not. The composite analysis projections for the sludge disposed of at MDA G are in general agreement with the historical sludge data. However, the composite analysis inventory for the nonsludge waste includes total and radionuclide-specific activities that are significantly higher than the activities indicated by the historical data.

Table 15
Comparison of Pre-1971 Radionuclide Inventories in Nonsludge Waste Streams

Source of Inventory Projections	Activity (Ci)						
	Pu-equiv.	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Am-241
Disposal Memoranda – Nonsludge Waste (Meyer, 1960)	3.0E+02	---	---	---	---	---	---
Handwritten Spreadsheet Calculations	---	---	9.1E+01	---	---	---	---
Workman	---	3.5E+00	6.7E+01	---	---	---	---
Wheeler (1974)	---	1.5E+01	3.3E+02	---	---	---	2.1E+03
Composite Analysis (Hollis et al., 1997)	---	---	---	---	---	---	---
Surface-Contaminated Waste [a]	1.5E+04 [b]	4.2E+03	1.8E+03	4.5E+02	8.2E+03	4.9E-02	4.4E+01
Soil	3.7E+01 [b]	3.1E-01	3.7E+01	---	---	---	---

--- = None

[a] *Entries represent the sum of pit and shaft inventories, although the vast majority of the waste was assumed to be disposed of in pits.*

[b] *Pu-equivalent activity was not calculated for the composite analysis; it is estimated here as the sum of the activities of Am-241 and isotopes of plutonium and uranium.*

The source of the discrepancy for the nonsludge waste streams is unclear. The activities listed in the 1997 composite analysis for the nonsludge waste were projected almost entirely by assuming the waste disposed of prior to 1971 resembled waste disposed of during the early to mid-1970s. If the historical waste records are deemed to be relatively complete, it would appear the extrapolation approach is inappropriate or that the waste characteristics that were extrapolated back in time are not representative of the material disposed of prior to 1971. However, if the historical disposal records do not represent all the waste disposed of at MDA G, the extrapolation approach used for the composite analysis inventory may, in fact, be more appropriate.

Although available information is inconclusive, it appears likely that the historical disposal data are incomplete with respect to the nonsludge waste streams disposed of at MDA G. Technical Area 21 was the primary generator of the plutonium isotopes included in Table 15 for the nonsludge waste streams. This facility was the site of plutonium operations from 1945 to 1978, a period that encompasses the 1971–1977 extrapolation period used in the 1997 composite analysis. There is no compelling reason to think the waste generated from 1971–1977 was unique or dissimilar to material generated prior to 1971.

Based on these considerations, it was decided that an extrapolation approach similar to the one used for the 1997 composite analysis would generate more appropriate estimates of the pre-1971 pit inventory. This approach appears to generate reliable inventory estimates for radionuclides in the sludge waste and is expected to provide better estimates of the radionuclides found in the nonsludge waste.

The historical records included in the pre-1971 data evaluation did not provide sufficient detail to estimate the shaft inventory. Therefore, extrapolation methods and alternative sources of information were investigated to develop the inventory for these units.

4.1.1.2 Pit and Shaft Inventory Estimates

The extrapolation process that is used to estimate the pre-1971 pit inventory relies upon post-1970 data from the LLW disposal and TRU waste databases to estimate the characteristics of the earlier waste. The period from which the extrapolation disposal data are drawn strongly influences the resulting inventory projections. Thus, the selected data need to be as representative of the 1957–1970 period as possible. Under ideal conditions, the operations generating waste would be identical for both periods. As the amount of elapsed time between the two time periods increases, however, the likelihood of satisfying this condition decreases. This is because the role of the Laboratory evolves over time, resulting in the phase out of some operations and the start up of new ones.

The 1997 composite analysis (Hollis et al., 1997) used LLW and TRU waste data for the 1971–1977 period to extrapolate pre-1971 pit inventories. This period was selected partly on the basis of the types and quantities of waste disposed of or placed in storage at MDA G from 1971 forward. Waste generated in 1971 is expected to closely resemble material generated prior to that year. The year 1977 was selected as the end of the extrapolation period because the nature of the LLW and TRU waste generated at the Laboratory changed shortly after that point in time. Although LLW pit disposal volumes and activities were relatively constant until 1978, there was a large increase in the activity of the LLW placed in these units in 1979. Similarly, the quantities of TRU waste placed in storage, and the radionuclide activities in that waste, increased substantially in the late 1970s and early 1980s. On the basis of these findings, the extrapolation period was ended in 1977 to minimize divergences between the extrapolated LLW and TRU waste inventories and the actual waste disposed of prior to 1971.

Conveniently, the 1971–1977 extrapolation period also excludes a number of unique waste streams associated with D&D and startup activities at the Laboratory, including those generated during the decommissioning of the TA-21 plutonium facility and the startup of TA-55. In addition, this period generally predates a number of changes in disposal operations at MDA G, including the implementation of waste compaction in 1977 and the end of mixed LLW disposal in the mid-1980s.

The 1971–1977 extrapolation period adopted by the 1997 composite analysis for the disposal pits was used in the inventory characterization update as well. The data for this period were examined to identify, to the extent possible, any nonroutine or special case waste that would not have been disposed of prior to 1971. As a result, the following wastes were eliminated from the LLW and TRU waste data used to estimate the pre-1971 inventories.

- All waste generated at TA-53, which was referred to as the Los Alamos Meson Physics Facility during the 1970s. This waste was excluded because the facility began operations in June 1972.

- All LLW and small amounts of TRU waste generated by the townsite (TA-1) cleanup activities that took place in the mid-1970s. This waste was excluded because no similar activities occurred prior to 1971.

- Radioactively contaminated soil generated at TA-0 and TA-43 in 1977 in conjunction with the removal of the acid sewer system. This waste was excluded because similar activities did not occur prior to 1971.

- High-activity Pu-238 and U-233 waste generated at TA-21 and stored in trenches A–C. The Pu-238 waste was shipped to the Savannah River Site for disposal prior to 1974. This waste was retrievably stored in the MDA G trenches when the Savannah site stopped accepting this waste. The Laboratory did not receive approval to dispose of the U-233 waste until after 1971. Because these wastes were retrievably stored or sent off site prior to 1971, they were excluded from the inventory estimates.

After the dataset to be used for the extrapolation was identified, the inventory for the pre-1971 pits was developed. With the exceptions noted above, all waste types disposed of in pits during the 1971–1977 period were assumed to have been placed in pits prior to 1971. A few TRU waste shipments included in the extrapolation process were placed in storage domes at MDA G; waste similar to this was assumed to have been disposed of in the pits prior to 1971. The total volumes and activities of waste projected for the three waste forms are summarized in Table 16. The extrapolation-based radionuclide-specific inventories estimated for the pre-1971 disposal pits are summarized in Table 17. Volumes and activities of waste estimated on the basis of the LLW disposal data and the TRU waste data are provided separately in each table.

Table 17 volumes represent the quantities of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of these volumes is greater than the total volume of waste disposed of in the pits. The listed activities represent as-disposed activities and include all contributions from MAP and MFP waste, and the material types discussed in Section 3.1. The listed inventories do not include the radionuclides eliminated on the basis of decay characteristics (see *Attachment I*).

Using the 1971–1977 pit waste data to infer the quantities and characteristics of the waste placed in MDA G prior to 1971 does not account for all material that was disposed of during the pre-1971 period. It is practically impossible to identify all unique disposal events that took place at MDA G before 1971. However, Warren (1980) identified several events that involved large quantities of specific radionuclides; these were not captured by the extrapolation process. Table 10 indicates the nature of the waste generated by these events.

Based on the information presented in Table 10, waste was added to the extrapolation-based pit inventory projections. The waste form, total volume and activity, and radiological characteristics of the waste represented by these additions are listed in Table 18. These additions were based on a number of assumptions. The sludge generated from 1952–1967 was assumed to be disposed of at MDAs C and G in equal amounts because the MDA G pits did not receive routine operational waste until the late 1950s. The masses listed for plutonium were assumed to be Pu-239 (Warren, 1996); the 590 g (1.3 lb) of Pu-equivalents were assumed to be 94 and 6 weight percent Pu-239 and Pu-240, respectively, based on information contained in Warren (1980) and Rogers (1977). All of the cement paste disposed of between 1959 and 1968 was assumed to be placed in pits at MDA G, although small quantities of it were probably placed in pits at MDA C.

Table 16
Pre-1971 Extrapolation-Based Estimates of Pit and Shaft Inventories

Waste Form by Disposal Unit	LLW		TRU Waste		All Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pit Waste (estimates based on 1971–1977 data)						
Surface-Contaminated Waste	3.5E+04	4.8E+02	1.7E+03	1.5E+04	3.7E+04	1.5E+04
Soil	5.7E+03	1.9E+00	6.8E+00	NA	5.7E+03	1.9E+00
Concrete and Sludge	4.1E+03	2.8E+02	1.9E+02	1.6E+02	4.3E+03	4.5E+02
Shaft Waste (estimates based on 1971–1975 data)						
Surface-Contaminated Waste	1.4E+02	3.5E+04	1.2E+00	8.3E+02	1.5E+02	3.6E+04
Soil	2.1E-02	NA	---	---	2.1E-02	0.0E+00
Concrete and Sludge	4.4E-01	NA	---	---	4.4E-01	0.0E+00
Shaft Waste estimates (based on 1971–1977 data)						
Surface-Contaminated Waste	1.3E+02	8.2E+04	1.7E+00	1.6E+03	1.3E+02	8.3E+04
Soil	1.5E-02	NA	---	---	1.5E-02	0.0E+00
Concrete and Sludge	3.1E-01	NA	---	---	3.1E-01	0.0E+00

NA = No activity: all disposal activities in the data used to project pre-1971 inventories were zero. *--- = None*

Table 17
Pre-1971 Extrapolation-Based Radionuclide Inventories for the Disposal Pits

Radionuclide by Waste Form	LLW		TRU Waste		All Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Surface-Contaminated Waste						
Ac-227	7.1E-01	1.2E-01	1.9E-01	7.4E-01	9.1E-01	8.6E-01
Am-241	---	---	4.6E+00	4.4E+01	4.6E+00	4.4E+01
Cf-249	9.7E-01	7.0E-04	3.6E-01	1.7E-03	1.3E+00	2.4E-03
Cf-251	---	---	1.5E-01	2.7E-03	1.5E-01	2.7E-03
Cf-252	4.9E-01	1.5E-02	---	---	4.9E-01	1.5E-02
Cm-244	---	---	3.6E-01	1.7E-03	3.6E-01	1.7E-03
Co-60	9.9E+01	1.1E-02	---	---	9.9E+01	1.1E-02
Cs-137	7.0E+01	3.6E-01	1.9E+01	1.4E+02	8.8E+01	1.4E+02
Eu-154	6.8E+01	3.3E-06	1.9E+01	4.5E-03	8.7E+01	4.5E-03
H-3	3.0E+01	2.7E+00	---	---	3.0E+01	2.7E+00
Kr-85	6.8E+01	9.8E-02	1.9E+01	1.3E+02	8.7E+01	1.3E+02
Np-237	---	---	5.5E-01	4.0E-03	5.5E-01	4.0E-03
Pu-238	1.2E+03	4.5E+02	6.1E+02	3.5E+03	1.8E+03	3.9E+03
Pu-239	7.7E+02	1.1E+00	5.7E+02	1.8E+03	1.3E+03	1.8E+03
Pu-240	7.6E+02	3.0E-03	5.4E+02	4.5E+02	1.3E+03	4.5E+02
Pu-241	7.6E+02	4.6E-02	5.4E+02	8.1E+03	1.3E+03	8.1E+03
Pu-242	7.6E+02	1.8E-07	5.4E+02	4.9E-02	1.3E+03	4.9E-02
Sm-151	6.8E+01	3.7E-07	1.9E+01	5.0E-04	8.7E+01	5.0E-04
Sn-121m	6.8E+01	3.9E-05	1.9E+01	5.2E-02	8.7E+01	5.2E-02
Sn-126	6.8E+01	9.3E-06	---	---	6.8E+01	9.3E-06
Sr-90	7.0E+01	4.1E-01	1.9E+01	1.5E+02	8.8E+01	1.5E+02
Th-230	1.9E-02	1.6E+01	---	---	1.9E-02	1.6E+01
Th-232	5.4E+00	1.7E-03	---	---	5.4E+00	1.7E-03
U-234	5.0E+01	1.8E+00	---	---	5.0E+01	1.8E+00
U-235	3.3E+02	4.4E-01	1.9E+01	2.2E-04	3.5E+02	4.4E-01
U-236	1.0E+01	9.6E-05	---	---	1.0E+01	9.6E-05
U-238	1.5E+02	9.8E+00	---	---	1.5E+02	9.8E+00

--- = None

Table 17 (Continued)
Pre-1971 Extrapolation-Based Radionuclide Inventories for the Disposal Pits

Radionuclide by Waste Form	LLW		TRU Waste		All Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Soil						
Co-60	1.9E-01	2.8E-04	---	---	1.9E-01	2.8E-04
Pu-238	1.0E+03	3.1E-01	---	---	1.0E+03	3.1E-01
Pu-239	1.0E+03	3.4E-02	---	---	1.0E+03	3.4E-02
Th-232	4.9E-03	1.9E-04	---	---	4.9E-03	1.9E-04
U-234	8.7E-02	3.9E-01	---	---	8.7E-02	3.9E-01
U-235	1.6E+01	1.5E-02	---	---	1.6E+01	1.5E-02
U-238	9.8E+01	1.1E+00	---	---	9.8E+01	1.1E+00
Concrete and Sludge						
Am-241	4.5E+02	7.2E-01	7.9E+01	3.8E+01	5.3E+02	3.8E+01
Co-60	1.9E-01	2.8E-04	---	---	1.9E-01	2.8E-04
Pu-238	1.7E+03	2.8E+02	1.5E+02	1.1E+02	1.8E+03	3.9E+02
Pu-239	1.6E+03	4.3E+00	1.6E+02	1.6E+01	1.8E+03	2.0E+01
U-235	8.2E+01	3.4E-03	3.2E+00	9.7E-05	8.5E+01	3.5E-03

--- = *None*

Adjustments to the pre-1971 pit inventories could not be made or were unnecessary for three entries in Table 10. Data needed to estimate radionuclide activities were unavailable for sludge generated at TA-45 from 1951–1963 and for sludge disposed of in pits from 1963–1971. Additions to the inventories to account for the waste placed in selected pits between 1972 and 1978 were not needed. The quantities and nature of the waste disposed of during this period were estimated using actual disposal data that capture the information summarized by Warren (1980).

The total pre-1971 pit inventory combines the extrapolation-based inventory summarized in Tables 16 and 17, and the waste included to account for nonroutine or unique disposals (Table 18). The pre-1971 total volumes and activities associated with each of the waste forms are summarized in Table 19, and the radionuclide-specific inventories in this waste are listed in Table 20. The volumes provided in Table 20 are the quantities of waste contaminated with each radionuclide; the sum of these volumes is greater than the volumes listed in Table 19 because several radionuclides may occur in a single waste package. All activities represent as-disposed activities, and include all contributions from MAP and MFP waste, and the material types discussed in Section 3.1. Inventories are not listed for the radionuclides that were eliminated on the basis of decay characteristics.

Table 18
Additions to Pre-1971 Extrapolation-Based Pit Inventory Projections

Waste	Waste Form	Total Volume (m^3)	Total Activity (Ci)	Radionuclide	Radionuclide Activity (Ci)
1952–1967 Sludge	Concrete/Sludge	3.1E+02	3.1E+01	Pu-239	2.7E+01
				Pu-240	4.0E+00
1959–1968 Cement Paste	Concrete/Sludge	2.5E+03	2.3E+03	Am-241	2.3E+03
				Pu-239	4.6E+01
				U-233	6.1E+00
1960 Soil	Soil	4.5E+00	3.7E+01	Pu-239	3.7E+01

Source: Warren (1980)

Table 19
Total Pre-1971 Inventory Projections for Pits

Waste Form	LLW		TRU Waste		All Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Surface-Contaminated Waste	3.6E+04	7.4E+02	1.7E+03	1.5E+04	3.7E+04	1.6E+04
Soil	5.7E+03	1.9E+00	1.1E+01	3.7E+01	5.7E+03	3.9E+01
Concrete and Sludge	4.1E+03	2.8E+02	3.0E+03	2.5E+03	7.0E+03	2.8E+03

LLW = Low-level waste *TRU = Transuranic*

The waste represented by the pre-1971 pit inventory is assumed to have been disposed of in pits 1–5. Approximately 10 percent of the waste that was disposed of in pit 5 was placed there after 1970. For simplicity, this waste was included in the pre-1971 inventory. Approximately 10 percent of the waste placed in pit 6 was disposed of prior to 1971; this waste was also included in the pit 1–5 inventory.

Table 20
Pre-1971 Radionuclide-Specific Inventory Projections for Pits

Radionuclide by Waste Form	LLW		TRU Waste		All Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Surface-Contaminated Waste						
Ac-227	7.1E-01	1.2E-01	1.9E-01	7.4E-01	9.1E-01	8.6E-01
Am-241	---	---	4.6E+00	4.4E+01	4.6E+00	4.4E+01
Cf-249	9.7E-01	7.0E-04	3.6E-01	1.7E-03	1.3E+00	2.4E-03
Cf-251	---	---	1.5E-01	2.7E-03	1.5E-01	2.7E-03
Cf-252	4.9E-01	1.5E-02	---	---	4.9E-01	1.5E-02
Cm-244	---	---	3.6E-01	1.7E-03	3.6E-01	1.7E-03
Co-60	9.9E+01	1.1E-02	---	---	9.9E+01	1.1E-02
Cs-137	7.0E+01	4.6E-01	1.9E+01	1.4E+02	8.8E+01	1.4E+02
Eu-154	6.8E+01	9.7E-06	1.9E+01	4.5E-03	8.7E+01	4.5E-03
H-3	3.0E+01	2.7E+00	---	---	3.0E+01	2.7E+00
Kr-85	6.8E+01	3.6E-02	1.9E+01	1.3E+02	8.7E+01	1.3E+02
Np-237	---	---	5.5E-01	4.0E-03	5.5E-01	4.0E-03
Pu-238	1.2E+03	7.1E+02	6.1E+02	3.5E+03	1.8E+03	4.2E+03
Pu-239	7.7E+02	1.1E+00	5.7E+02	1.8E+03	1.3E+03	1.8E+03
Pu-240	7.6E+02	3.0E-03	5.4E+02	4.5E+02	1.3E+03	4.5E+02
Pu-241	7.6E+02	4.6E-02	5.4E+02	8.1E+03	1.3E+03	8.1E+03
Pu-242	7.6E+02	1.8E-07	5.4E+02	4.9E-02	1.3E+03	4.9E-02
Sm-151	6.8E+01	1.3E-06	1.9E+01	5.0E-04	8.7E+01	5.0E-04
Sn-121m	6.8E+01	8.1E-05	1.9E+01	5.2E-02	8.7E+01	5.2E-02
Sn-126	6.8E+01	9.3E-06	---	---	6.8E+01	9.3E-06
Sr-90	7.0E+01	3.5E-01	1.9E+01	1.5E+02	8.8E+01	1.5E+02
Th-230	1.9E-02	1.6E+01	---	---	1.9E-02	1.6E+01
Th-232	5.4E+00	1.7E-03	---	---	5.4E+00	1.7E-03
U-234	5.0E+01	1.8E+00	---	---	5.0E+01	1.8E+00
U-235	3.5E+02	4.4E-01	1.9E+01	2.2E-04	3.7E+02	4.4E-01
U-236	5.0E+01	9.6E-05	---	---	5.0E+01	9.6E-05
U-238	1.6E+02	9.8E+00	---	---	1.6E+02	9.8E+00

LLW = Low-level waste *TRU = Transuranic* *--- = None*

Table 20 (Continued)
Pre-1971 Radionuclide-Specific Inventory Projections for Pits

Radionuclide by Waste Form	LLW		TRU Waste		All Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Soil						
Co-60	1.9E-01	2.8E-04	---	---	1.9E-01	2.8E-04
Pu-238	1.0E+03	3.1E-01	---	---	1.0E+03	3.1E-01
Pu-239	1.0E+03	3.4E-02	4.5E+00	3.7E+01	1.0E+03	3.7E+01
Th-232	4.9E-03	1.9E-04	---	---	4.9E-03	1.9E-04
U-234	8.7E-02	3.9E-01	---	---	8.7E-02	3.9E-01
U-235	1.6E+01	1.5E-02	---	---	1.6E+01	1.5E-02
U-238	9.8E+01	1.1E+00	---	---	9.8E+01	1.1E+00
Concrete and Sludge						
Am-241	4.5E+02	7.2E-01	2.5E+03	2.3E+03	3.0E+03	2.3E+03
Co-60	1.9E-01	2.8E-04	---	---	1.9E-01	2.8E-04
Pu-238	1.7E+03	2.8E+02	1.5E+02	1.1E+02	1.8E+03	3.9E+02
Pu-239	1.6E+03	4.3E+00	2.9E+03	8.9E+01	4.6E+03	9.3E+01
Pu-240	---	---	3.1E+02	4.0E+00	3.1E+02	4.0E+00
U-233	---	---	2.5E+03	6.1E+00	2.5E+03	6.1E+00
U-235	8.2E+01	3.4E-03	3.2E+00	9.7E-05	8.5E+01	3.5E-03

LLW = Low-level waste *TRU = Transuranic* *--- = None*

The 1997 composite analysis shaft inventory was estimated through an extrapolation process that used 1971–1975 waste data. As discussed in Section 3.1, Warren (1996) suggested alternative methods for estimating this inventory, including the use of pre-1971 disposal records. This suggestion was made because the quality of pre-1971 shaft data was expected to be similar to the quality of the 1971–1975 shaft data. Use of the 1971–1977 dataset as the basis for estimating the characteristics of the pre-1971 waste through extrapolation was also mentioned by Warren, because the overall quality of these data may be greater than that seen for the 1971–1975 data. Both of these approaches were evaluated as part of the inventory characterization update.

The shaft waste inventories projected using the extrapolation approach are included in Table 16. The projected volumes of shaft waste are similar for both extrapolation datasets (1971–1975 and 1971–1977). However, the total activity projected using the 1971–1977 data is significantly higher than that calculated using the 1971–1975 data. In both cases, the majority of the projected activity is estimated on the basis of LLW disposal data.

Rogers (1977) summarizes the MDA G shaft disposal data for waste placed in these units from 1966 through early 1976. A subset of these data (1966 through December 1970) was used to estimate the pre-1971 shaft inventory directly, as suggested by Warren (1996); this subset is referred to as the *historical shaft data* or *historical disposal records* in the following discussion. The data used in this analysis are provided in *Attachment II.* Table II-1 provides disposal information for all pre-1971 shipments that include estimates of radionuclide mass or activity. Numerous records included in Rogers provide estimates of disposal volumes but no indication of contaminant quantity. The volumes were extracted from these records to estimate the total volumes of waste disposed of in shafts prior to 1971; these volumes are summarized in Table II-2.

The pre-1971 historical shaft data in Rogers (1977) provide estimates of radionuclide content in terms of mass for some wastes and in terms of activity for others. The conversion of mass to activity and the assignment of activities to specific radionuclides for this inventory update were based on several assumptions, including:

- The masses listed for TRU waste were assigned to the radionuclides indicated in the waste description; listed activities were divided equally among all listed radionuclides. All plutonium waste was assumed to be Pu-239 unless otherwise indicated. The masses listed for TRU waste that did not have any radionuclide identifier were assumed to represent Pu-239.

- The masses listed for the uranium waste were assigned to the radionuclides included in the waste description; listed activities were divided equally among all listed isotopes. All uranium was assumed to be U-235 unless otherwise indicated. The masses listed for waste packages that did not have any radionuclide identifier were assumed to be U-235.

- MAP and MFP activities were assigned to specific radionuclides when the necessary information was provided in the disposal records; listed activities were divided equally among all listed radionuclides.

- The activation-product activities were assigned to specific radionuclides when the necessary information was provided in the disposal records; specific isotopes were not defined for the tantalum activities.

- The radium sources listed under the "Other" category were assumed to be Ra-226, while the thorium waste was assumed to be Th-232; masses listed for silver and platinum were not accounted for in the activity calculations because it was not clear what isotopes were present in the waste.

The historical disposal records for the shafts indicate that 48 m^3 (160 ft^3) of waste was disposed of prior to 1970; the material had a total activity of 6.4×10^4 Ci (Rogers, 1977). This is about one-third of the volume projected using the extrapolation approach (Table 16). Overall, the total volume of waste disposed of in shafts that were active prior to 1971 is about 80 m^3 (280 ft^3) or about 45 percent of the disposal capacity. This emplacement efficiency fraction is similar to that seen for other shafts at MDA G. Emplacement efficiencies calculated using the extrapolated volumes of shaft waste are on the order of 70 to 80 percent. These efficiencies are higher than normal and suggest that the extrapolation approach overestimates actual waste volumes. The total activity of the waste that was estimated using the historical disposal records is intermediate between the activities calculated using the 1971–1975 and 1971–1977 extrapolation datasets.

The radionuclide-specific inventories estimated using the two extrapolation datasets and the historical shaft data (Rogers, 1977) are provided in Table 21. Examination of these results indicates that the radionuclide-specific activities estimated using the 1971–1977 extrapolation dataset are generally similar to, or greater than, those estimated using the 1971–1975 dataset. Radionuclide-specific activities estimated using the pre-1971 disposal records are similar to or less than those projected using the extrapolation approach for the plutonium and uranium isotopes; the tritium inventory projected using the actual disposal data falls between the two extrapolation-based estimates. The inventory projections based on the historical shaft data yield the lowest activity of MAP waste, but the greatest activity of MFP waste.

Table 21
Comparison of Pre-1971 Shaft Radionuclide Activities Projected from Extrapolation Datasets and Pre-1971 Disposal Data

Constituent	Projected Activity (Ci)		
	1971–1975 Extrapolation Dataset	1971–1977 Extrapolation Dataset	Pre-1971 Shaft Data [a]
Am-241	3.4E-08	2.7E-02	---
Am-243	---	7.7E-06	2.0E-02
Be-7	1.2E+02	8.3E+01	---
Ce-137	---	---	5.0E-01
Cf-252	5.5E+01	3.9E+01	8.0E+00
Cm-244	1.9E-01	1.3E-01	2.3E-04
Co-57	1.0E-03	7.1E-04	5.0E-01

--- = None *MAP = Mixed-activation products* *MFP = Mixed-fission products*

[a] *From Rogers, 1977*

[b] *Pre-1971 shaft disposal MAP data includes the 0.5 Ci assigned to Co-57*

[c] *Pre-1971 shaft disposal MFP includes 2.6 Ci assigned to Co-60, Cs-134, Cs-137, Eu-152, Sr-90, and Zn-65*

Table 21 (Continued)
Comparison of Pre-1971 Shaft Radionuclide Activities Projected from Extrapolation Datasets and Pre-1971 Disposal Data

Constituent	Projected Activity (Ci)		
	1971–1975 Extrapolation Dataset	1971–1977 Extrapolation Dataset	Pre-1971 Shaft Data [a]
Co-60	1.0E+00	7.3E-01	1.8E+01
Cs-134	---	---	1.2E-01
Cs-137	5.0E-03	3.6E-03	6.3E-01
Eu-152	---	---	1.2E-01
H-3	3.4E+04	8.0E+04	6.1E+04
MAP	3.7E+02	2.6E+02	1.0E+02 [b]
MFP	1.7E+03	2.4E+03	2.7E+03 [c]
Np-237	7.0E-05	5.0E-05	1.4E-04
Po-210	2.0E-02	1.8E-02	1.0E-01
Pu-238	1.1E+00	8.5E-01	5.6E+00
Pu-239	5.0E+01	5.1E+01	2.1E+01
Pu-240	1.0E+00	1.2E+00	3.4E-02
Pu-241	1.6E+01	1.9E+01	5.4E-03
Pu-242	5.8E-05	7.2E-05	1.2E-04
Ra-226	---	2.6E-04	1.0E-01
Sr-90	4.9E-08	3.5E-08	1.1E+00
Th-232	1.1E-02	1.0E-02	3.1E+00
U-232	2.1E-01	1.5E-01	---
U-233	4.0E+00	2.8E+00	1.5E+00
U-234	4.8E-02	8.0E-02	2.3E-01
U-235	8.3E-03	9.3E-03	1.3E-02
U-236	1.8E-04	1.3E-04	1.2E-07
U-238	4.4E+00	3.4E+00	3.1E-05
Zn-65	---	---	1.2E-01

--- = None *MAP = Mixed-activation products* *MFP = Mixed-fission products*

[a] From Rogers, 1977

[b] Pre-1971 shaft disposal MAP data includes the 0.5 Ci assigned to Co-57

[c] Pre-1971 shaft disposal MFP includes 2.6 Ci assigned to Co-60, Cs-134, Cs-137, Eu-152, Sr-90, and Zn-65

The inventory projections developed for the shafts using the historical disposal records and the extrapolation approach were evaluated to determine which estimates should be used in the 2005 updated inventory. Bases of comparison included total waste volume and projected radionuclide-specific activities. From the perspective of waste volume, the inventory projections based on the pre-1971 historical disposal records appear most reasonable. As discussed earlier, the emplacement efficiency indicated by the projected waste volume is consistent with historical patterns of shaft usage; the volumes of waste projected through the extrapolation process imply emplacement efficiencies that appear to be unrealistic.

The radionuclide-specific inventories projected using the historical shaft data and the extrapolation approach were compared to inventory estimates reported by Rogers (1977); this comparison is shown in Table 22. The table lists as-disposed activities for the inventories developed using the pre-1971 disposal records and the extrapolation approach. The inventory provided by Rogers includes waste disposed of in shafts through 1975; the listed activities are decay corrected to January 1976.

Among the radionuclides common to the four inventories (Table 22), the activities of several radionuclides projected using the pre-1971 historical disposal data tend to be greater than those estimated using the extrapolation approach. Examples include Co-60, Cs-137, and Sr-90. However, the activities based on both the historical shaft data and extrapolation approaches are much less than the activities reported by Rogers. Although some of this discrepancy is doubtless introduced by the fact that the Rogers activities pertain to waste disposed of through 1975, it is not clear that the observed differences are fully explained by this factor.

The tritium activities listed in Table 22 must be adjusted before the different sets of inventory projections can be compared. Toward this end, the tritium activities projected using the historical data and the extrapolation approach were decayed to January 1976 and the waste disposed of after 1970 was excluded from the Rogers inventory. The activity estimated by the historical data records was decayed to January 1976 using the dates of disposal listed in the disposal records. The extrapolation-based activities were decayed based on the assumption that the tritium waste was placed in the shafts at a uniform rate between the time of the first shaft disposal in 1966 and the end of 1970. The post-1970 tritium waste disposals listed in Rogers were decayed to 1976 and subtracted from the total tritium inventory listed in the Rogers report. The decay-corrected tritium activities estimated using the historical data, the 1971–1975 extrapolation dataset, and the 1971–1977 extrapolation dataset are 4.4×10^4, 2.3×10^4, and 5.4×10^4 Ci, respectively. Subtracting the post-1970 disposals from the Rogers inventory of 9.2×10^4 Ci yields a tritium inventory of 6.2×10^4 Ci.

Table 22
Comparison of Various Pre-1971 Shaft Radionuclide-Specific Inventories

Constituent	Projected Activity (Ci) [a]			
	Pre-1971 Shaft Data [b]	Extrapolation Approach		Rogers Inventory [c]
		1971–1975 Dataset	1971–1977 Dataset	
Am-241	---	3.4E-08	2.7E-02	---
Am-243	2.0E-02	---	7.7E-06	---
Be-7	---	1.2E+02	8.3E+01	---
Ce-137	5.0E-01	---	---	---
Cf-252	8.0E+00	5.5E+01	3.9E+01	---
Cm-244	2.3E-04	1.9E-01	1.3E-01	---
Co-57	5.0E-01	1.0E-03	7.1E-04	---
Co-60	1.8E+01	1.0E+00	7.3E-01	1.5E+02
Cs-134	1.2E-01	---	---	---
Cs-137	6.3E-01	5.0E-03	3.6E-03	6.0E+00
Eu-152	1.2E-01	---	---	---
H-3	6.1E+04	3.4E+04	8.0E+04	9.2E+04
MAP	1.0E+02	3.7E+02	2.6E+02	6.6E+02
MFP	2.7E+03	1.7E+03	2.4E+03	2.0E+02
Na-22	---	---	---	2.0E+01
Np-237	1.4E-04	7.0E-05	5.0E-05	---
Po-210	1.0E-01	2.0E-02	1.8E-02	---
Pu-238	5.6E+00	1.1E+00	8.5E-01	4.0E+00
Pu-239	2.1E+01	5.0E+01	5.1E+01	4.6E+01
Pu-240	3.4E-02	1.0E+00	1.2E+00	---
Pu-241	5.4E-03	1.6E+01	1.9E+01	---
Pu-242	1.2E-04	5.8E-05	7.2E-05	---
Ra-226	1.0E-01	---	2.6E-04	---
Sr-90	1.1E+00	4.9E-08	3.5E-08	2.8E+02
Th-232	3.1E+00	1.1E-02	1.0E-02	---
U [d]	---	---	---	< 1.0E+00
U-232	---	2.1E-01	1.5E-01	---

--- = None *MAP = Mixed-activation products* *MFP = Mixed-fission products*

[a] The inventory projections based on the historical data and the extrapolation approach are as-disposed activities for the 1966 to 1970 period; the radionuclide activities listed for the Rogers report pertain to the 1965 to 1975 period and are decay corrected to January 1976.

[b] Based on historical shaft data from Rogers, 1977 *[c] From data summarized in Rogers (1977), Table G-IV*

[d] Includes U-234, U-235, U-236, and U-238

Table 22 (Continued)
Comparison of Various Pre-1971 Shaft Radionuclide-Specific Inventories

Constituent	Projected Activity (Ci) [a]			
	Pre-1971 Shaft Data [b]	Extrapolation Approach		Rogers Inventory [c]
		1971–1975 Dataset	1971–1977 Dataset	
U-233	1.5E+00	4.0E+00	2.8E+00	5.0E+00
U-234	2.3E-01	4.8E-02	8.0E-02	---
U-235	1.3E-02	8.3E-03	9.3E-03	---
U-236	1.2E-07	1.8E-04	1.3E-04	---
U-238	3.1E-05	4.4E+00	3.4E+00	---
Zn-65	1.2E-01	---	---	---

--- = None *MAP = Mixed-activation products* *MFP = Mixed-fission products*

[a] The inventory projections based on the historical data and the extrapolation approach are as-disposed activities for the 1966 to 1970 period; the radionuclide activities listed for the Rogers report pertain to the 1965 to 1975 period and are decay corrected to January 1976.

[b] Based on historical shaft data from Rogers, 1977 *[c] From data summarized in Rogers (1977), Table G-IV*

[d] Includes U-234, U-235, U-236, and U-238

The tritium activity projected using the historical data is intermediate between the two extrapolation-based estimates, and about 70 percent of the corresponding inventory listed in the Rogers report. The extrapolation process using the 1971–1975 dataset significantly underestimates the tritium inventory. The extrapolation-based estimate developed using the 1971–1977 dataset falls within 13 percent of the Rogers inventory.

The activity estimated for Pu-238 using the historical data generally agrees with the Rogers inventory. The Pu-239 inventory developed using the historical data is approximately 50 percent of the corresponding activity listed by Rogers. However, a large portion of the activity listed in the Rogers report was disposed of from 1971–1975. When these disposals are accounted for, it appears the activity estimates based on the historical data and the Rogers inventory will both be much smaller than the 50 Ci inventories projected using the extrapolation process.

The U-233 activity projected using the historical shaft data is lower than the activity listed by Rogers. Approximately 4 Ci of this isotope's inventory was disposed of from 1971–1975. When this activity is subtracted from the inventory cited by Rogers, the result is essentially the same as that projected using the historical shaft data, but still less than the extrapolation-based activities estimated for this radionuclide. The sum of the U-234, U-235, U-236, and U-238 activities estimated using the historical data is less than 1 Ci, consistent with the Rogers uranium inventory. The extrapolation-based approach estimates a total activity for these isotopes that is greater than 1 Ci.

The activities of MAP and MFP waste projected using historical data and the extrapolation approach all differ significantly from the activities reported by Rogers (Table 22). The projected activities of the MAP waste are less than the Rogers inventory, while much higher activities are projected for the MFP waste relative to the Rogers data. The differences observed for the MAP waste may be due, in part, to the longer period of disposal addressed by the Rogers data. The fact that the MAP and MFP inventories listed in Rogers are decayed to January 1976 and the other estimates are not also helps explain the differences because many activation and fission products are very short-lived, leading to significant changes in the activity of the waste over relatively short periods of time.

The shaft inventory estimated using the historical pre-1971 disposal records from Rogers (1977) was adopted for the inventory characterization update on the basis of the comparison described above. The historical data appear to estimate more realistic volumes of waste for the pre-1971 period. Furthermore, the use of these data is expected to result in inventories of plutonium and uranium isotopes that are more accurate than the extrapolation-based inventories. Although discrepancies exist between the adopted inventory and the Rogers inventory for several other radionuclides, it is not clear that the extrapolation-based inventories are consistently more accurate than the inventory estimated using the historical data.

The radionuclide-specific inventories for the pre-1971 shafts are summarized in Table 23. All waste was assumed to be surface-contaminated waste because the information needed to assign the material to alternate waste forms was unavailable. The volumes listed in the table represent the quantity of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of these volumes is greater than the total volume of waste disposed of in the shafts. The radionuclide activities listed in Table 22 represent as-disposed activities and include all contributions from MAP and MFP waste and the material types discussed earlier. The listed radionuclides are those remaining after the half-life screen is applied as described in *Attachment I*.

4.1.2 Waste Inventory for 1971 through September 26, 1988

A total of 25 pits and 140 shafts were used to dispose of waste at MDA G from the beginning of 1971 through September 26, 1988. The total volumes and activities of waste placed in these units during this period are listed in Table 24; volumes and activities are segregated by the three waste forms (surface-contaminated waste, soil, and concrete and sludge). Individual totals are reported for the pits, while the inventories are summed over the shafts.

Table 23
Selected Pre-1971 Radionuclide-Specific Inventory Projections for Shafts

Radionuclide	Surface-Contaminated Waste [a]	
	Volume (m³)	Activity (Ci)
Am-243	1.4E-02	2.0E-02
Cf-252	2.8E-02	8.0E+00
Cm-244	2.8E-02	2.3E-04
Co-60	7.9E+00	2.1E+01
Cs-137	4.9E+00	3.7E+02
Eu-152	8.5E-02	1.2E-01
Eu-154	4.7E+00	1.2E-02
H-3	8.2E-01	6.1E+04
Kr-85	4.7E+00	3.4E+02
Np-237	3.1E-02	1.4E-04
Pu-238	2.0E-01	5.6E+00
Pu-239	1.1E+00	2.1E+01
Pu-240	1.7E-01	3.4E-02
Pu-241	1.1E-01	5.4E-03
Pu-242	2.8E-03	1.2E-04
Ra-226	5.7E-02	1.0E-01
Sm-151	4.7E+00	1.3E-03
Sn-121m	4.7E+00	1.4E-01
Sn-126	4.7E+00	3.3E-02
Sr-90	4.8E+00	4.0E+02
Th-232	5.7E-02	3.1E+00
U-233	1.9E-01	1.5E+00
U-234	3.3E-01	2.3E-01
U-235	5.7E+00	1.3E-02
U-236	1.1E-01	1.2E-07
U-238	5.5E-01	3.1E-05

[a] *Based on historical shaft data from Rogers (1977)*

Table 24
Volumes and Activities of Waste Disposed of in MDA G Pits and Shafts, 1971 through September 26, 1988

Waste Form by Disposal Unit	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit 6		
Surface-Contaminated Waste	4.6E+03	0.0E+00
Soil	4.0E+02	0.0E+00
Concrete and Sludge	4.3E+02	1.9E+02
Pit 7		
Surface-contaminated waste	2.0E+03	1.6E-01
Soil	1.0E+03	2.0E-01
Concrete and Sludge	2.6E+02	2.0E+01
Pit 8		
Surface-Contaminated Waste	7.7E+02	3.3E-05
Soil	2.8E+02	0.0E+00
Concrete and Sludge	7.8E+02	2.1E+01
Pit 9		
Surface-Contaminated Waste	4.8E+00	1.2E+00
Soil	0.0E+00	0.0E+00
Concrete and Sludge	0.0E+00	0.0E+00
Pit 10		
Surface-Contaminated Waste	2.5E+03	6.8E+03
Soil	4.1E+02	1.5E+00
Concrete and Sludge	2.1E+02	1.3E+00
Pit 12		
Surface-Contaminated Waste	6.4E+02	8.3E-03
Soil	9.3E+02	0.0E+00
Concrete and Sludge	2.4E+02	3.4E-01
Pit 13		
Surface-Contaminated Waste	1.2E+03	1.7E+00
Soil	2.8E+02	4.2E-01
Concrete and Sludge	4.9E+01	4.3E-06

Table 24 (Continued)
Volumes and Activities of Waste Disposed of in MDA G Pits and Shafts, 1971 through September 26, 1988

Waste Form by Disposal Unit	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit 16		
Surface-Contaminated Waste	1.6E+03	1.9E+00
Soil	8.9E+01	3.4E-02
Concrete and Sludge	1.6E+00	0.0E+00
Pit 17		
Surface-Contaminated Waste	3.1E+03	7.0E-02
Soil	3.5E+02	0.0E+00
Concrete and Sludge	3.6E+02	0.0E+00
Pit 18		
Surface-Contaminated Waste	6.6E+03	3.0E+04
Soil	2.3E+03	6.4E-01
Concrete and Sludge	6.3E+02	2.5E+00
Pit 19		
Surface-Contaminated Waste	5.3E+01	3.0E-01
Soil	9.0E-01	0.0E+00
Concrete and Sludge	9.0E-01	0.0E+00
Pit 20		
Surface-Contaminated Waste	1.2E+03	1.4E+00
Soil	1.0E+04	0.0E+00
Concrete and Sludge	2.0E+02	4.9E+00
Pit 21		
Surface-Contaminated Waste	2.5E+03	5.5E-01
Soil	2.4E+02	0.0E+00
Concrete and Sludge	2.1E+01	0.0E+00
Pit 22		
Surface-Contaminated Waste	1.3E+03	6.0E+02
Soil	1.4E+03	1.8E-01
Concrete and Sludge	1.5E+02	1.0E+00

Table 24 (Continued)
Volumes and Activities of Waste Disposed of in MDA G Pits and Shafts, 1971 through September 26, 1988

Waste Form by Disposal Unit	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit 24		
Surface-Contaminated Waste	1.5E+03	1.4E+01
Soil	4.1E+03	2.8E-01
Concrete and Sludge	1.1E+01	5.0E-03
Pit 25		
Surface-Contaminated Waste	3.9E+03	3.7E+02
Soil	5.4E+02	3.2E-01
Concrete and Sludge	1.9E+02	0.0E+00
Pit 26		
Surface-Contaminated Waste	2.2E+03	9.7E+01
Soil	1.0E+03	1.9E+00
Concrete and Sludge	5.8E+02	1.7E+01
Pit 27		
Surface-Contaminated Waste	3.2E+03	1.9E+02
Soil	2.7E+03	9.9E-01
Concrete and Sludge	2.1E+02	6.4E-03
Pit 28		
Surface-Contaminated Waste	2.1E+03	1.3E+03
Soil	1.3E+03	5.9E-01
Concrete and Sludge	2.6E+02	1.1E-01
Pit 29		
Surface-Contaminated Waste	4.4E+03	2.3E+03
Soil	2.9E+03	3.3E+00
Concrete and Sludge	4.8E+02	2.9E+00
Pit 32		
Surface-Contaminated Waste	3.3E+03	1.4E+02
Soil	1.0E+03	1.0E+01
Concrete and Sludge	3.1E+02	7.0E+00

Table 24 (Continued)
Volumes and Activities of Waste Disposed of in MDA G Pits and Shafts, 1971 through September 26, 1988

Waste Form by Disposal Unit	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit 33		
Surface-Contaminated Waste	4.9E+03	5.1E+01
Soil	1.1E+03	7.0E-01
Concrete and Sludge	6.0E+02	1.3E+00
Pit 35		
Surface-Contaminated Waste	2.0E+03	7.8E+01
Soil	6.6E+02	5.6E-01
Concrete and Sludge	1.8E+02	1.6E+00
Pit 36		
Surface-Contaminated Waste	2.5E+03	3.6E+01
Soil	2.6E+02	6.6E-02
Concrete and Sludge	1.7E+02	5.7E-01
Shafts		
Surface-Contaminated Waste	9.0E+02	8.2E+05
Soil	9.0E+00	1.0E+02
Concrete and Sludge	7.1E-01	1.0E+02

Waste was disposed of in pits 5 and 6 before and after the start of 1971. All waste placed in pit 5 and waste placed in pit 6 prior to 1971 was included in the pre-1971 inventory; the waste placed in pit 6 after 1970 was included in the 1971 to September 26, 1988 inventory. One shipment of waste was disposed of in pit 32 after September 26, 1988. For simplicity, this shipment is included in the waste data presented in this section. Pit 36 and several shafts were used both before and after September 26, 1988. The inventories listed in Table 24 include only the waste placed in those units through September 26, 1988. Pit 9 was used for the disposal of small amounts of LLW and the retrievable storage of TRU waste. Although the LLW will probably be removed during the retrieval of the TRU waste, it was included in MDA G inventory.

The radionuclide-specific inventories in the 1971 through September 26, 1988 waste are listed in Tables 25 and 26 for the pits and shafts, respectively. Individual inventories are provided for each pit, but inventories are summed for all of the shafts. Volumes provided in the tables represent the quantities of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of the waste package volumes is greater than the total volume of waste disposed of in the pits and shafts. The listed activities represent as-disposed activities, and include all contributions from MAP and MFP waste, and the material types discussed earlier. The listed inventories do not include the radionuclides that were eliminated on the basis of decay characteristics as described in *Attachment I*.

Transuranic waste was nonretrievably disposed of in pits 6, 7, 8, 20, and 22 and in several shafts from 1971-1979. Table 27 lists the total volumes and activities of TRU waste by waste form; radionuclide-specific inventories for the waste are listed in Table 28. In each case, individual totals are reported for the affected pits, while inventory data are summed over the shafts. These TRU waste data are also included in the radionuclide inventories shown in Tables 24–26.

4.1.3 Waste Inventory for September 27, 1988 through 2003

The LLW disposed of at MDA G from September 27, 1988 through the end of 2003 was placed in 7 pits and almost 70 shafts. The total volumes and activities of waste placed in these units are listed in Table 29 for the three waste forms described earlier. Individual totals are reported for each pit, while the inventories are summed over the shafts. As discussed, one waste shipment was disposed of in pit 32 after September 26, 1988; that waste is included in the 1971 through September 26, 1988 inventory (see Section 4.1.2).

Table 25
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form: Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pit 6						
Pu-238	---	---	---	---	1.0E+02	1.8E+02
Pu-239	---	---	---	---	1.1E+02	3.8E+00
Pit 7						
Am-241	---	---	---	---	1.9E+00	1.3E-01
Cf-252	2.8E-01	8.6E-03	---	---	---	---
Co-60	6.1E+00	1.8E-03	---	---	---	---
Cs-137	1.7E+01	6.4E-03	---	---	---	---
Eu-154	1.7E+01	2.0E-07	---	---	---	---
Kr-85	1.7E+01	5.9E-03	---	---	---	---
Pu-238	2.5E+02	4.7E-02	6.0E+02	1.8E-01	1.9E+02	2.0E+01
Pu-239	1.4E+02	5.3E-03	6.0E+02	2.0E-02	1.7E+02	4.0E-01
Pu-240	1.4E+02	1.2E-04	---	---	---	---
Pu-241	1.4E+02	1.7E-03	---	---	---	---
Pu-242	1.4E+02	6.7E-09	---	---	---	---
Sm-151	1.7E+01	2.3E-08	---	---	---	---
Sn-121m	1.7E+01	2.4E-06	---	---	---	---
Sn-126	1.7E+01	5.8E-07	---	---	---	---
Sr-90	1.7E+01	7.0E-03	---	---	---	---
U-235	1.0E+00	8.6E-05	---	---	4.7E+01	1.6E-03
Pit 8						
Am-241	---	---	---	---	2.5E+02	9.7E-01
Pu-238	---	---	---	---	4.9E+02	1.6E+01
Pu-239	---	---	---	---	4.9E+02	3.5E+00
Th-232	1.4E+00	3.3E-05	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pit 9						
Cs-137	7.6E-03	1.4E-01	---	---	---	---
Eu-154	7.6E-03	4.3E-06	---	---	---	---
Kr-85	7.6E-03	1.3E-01	---	---	---	---
Pu-238	3.4E+00	1.8E-01	---	---	---	---
Sm-151	7.6E-03	4.8E-07	---	---	---	---
Sn-121m	7.6E-03	5.0E-05	---	---	---	---
Sn-126	7.6E-03	1.2E-05	---	---	---	---
Sr-90	7.6E-03	1.5E-01	---	---	---	---
Pit 10						
Am-241	3.2E+00	1.0E-03	---	---	---	---
C-14	1.1E+00	9.0E-07	---	---	---	---
Cf-252	2.8E-02	8.0E-06	---	---	---	---
Co-60	3.1E+01	2.5E+01	6.2E-01	9.9E-06	---	---
Cs-137	1.0E+02	8.4E-03	4.9E+01	5.1E-07	6.9E+00	5.0E-07
Eu-154	7.8E+00	2.2E-07	---	---	---	---
H-3	1.1E+02	6.1E+03	1.5E+01	1.3E+00	1.5E+01	1.3E+00
Kr-85	7.8E+00	6.4E-03	---	---	---	---
Pu-238	1.4E+02	2.3E-02	---	---	---	---
Pu-239	3.8E+02	5.5E-02	3.5E+01	5.0E-07	6.9E+00	5.0E-07
Pu-240	1.2E+02	6.3E-04	---	---	---	---
Pu-241	1.2E+02	9.5E-03	---	---	---	---
Pu-242	1.2E+02	3.6E-08	---	---	---	---
Ra-226	2.1E-01	9.9E-02	---	---	---	---
Sm-151	7.8E+00	2.5E-08	---	---	---	---
Sn-121m	7.8E+00	2.6E-06	---	---	---	---
Sn-126	7.8E+00	6.3E-07	---	---	---	---
Sr-90	2.8E+02	2.2E-01	5.4E+01	5.1E-07	1.2E+01	5.0E-07

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Th-232	1.8E+00	4.4E-04	---	---	---	---
U-233	2.1E-01	1.9E-05	---	---	---	---
U-234	6.8E-01	7.2E-02	1.4E-02	7.0E-03	---	---
U-235	7.1E+01	1.1E-02	1.4E-02	2.7E-04	---	---
U-236	2.1E-01	6.3E-08	---	---	---	---
U-238	2.7E+01	1.5E+00	5.1E-02	2.1E-01	---	---
Pit 12						
Cs-137	3.8E+00	1.1E-03	---	---	---	---
Eu-154	3.8E+00	3.8E-08	---	---	---	---
Kr-85	3.8E+00	1.0E-03	---	---	---	---
Pu-238	2.1E+01	5.6E-05	---	---	1.2E+01	2.7E-01
Pu-239	1.2E+01	4.4E-05	---	---	1.2E+01	7.1E-02
Pu-240	1.2E+01	1.0E-05	---	---	---	---
Pu-241	1.2E+01	1.5E-04	---	---	---	---
Pu-242	1.2E+01	5.9E-10	---	---	---	---
Sm-151	3.8E+00	3.9E-09	---	---	---	---
Sn-121m	3.8E+00	4.0E-07	---	---	---	---
Sn-126	3.8E+00	9.9E-08	---	---	---	---
Sr-90	3.8E+00	1.2E-03	---	---	---	---
Pit 13						
Co-60	2.4E+01	1.2E-03	1.1E+00	1.4E-07	1.1E+00	1.4E-07
Cs-137	5.7E+00	2.0E-03	---	---	---	---
Eu-154	5.7E+00	6.5E-08	---	---	---	---
H-3	4.4E+00	5.0E-01	---	---	---	---
Kr-85	5.7E+00	1.9E-03	---	---	---	---
Sm-151	5.7E+00	7.2E-09	---	---	---	---
Sn-121m	5.7E+00	7.5E-07	---	---	---	---
Sn-126	5.7E+00	1.9E-07	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits,
1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Sr-90	5.7E+00	2.2E-03	---	---	---	---
U-234	1.5E+00	9.9E-03	2.8E-02	1.1E-01	---	---
U-235	6.4E+00	3.8E-04	9.0E+00	4.4E-03	9.9E-01	2.5E-10
U-238	2.1E+01	1.2E+00	3.2E+01	3.0E-01	---	---
Pit 16						
Co-60	1.1E+01	4.0E-03	---	---	---	---
Th-232	1.7E+00	6.5E-04	---	---	---	---
U-234	7.4E+00	1.3E-01	---	---	---	---
U-235	2.7E+01	4.3E-02	---	---	---	---
U-236	3.8E+00	5.3E-05	---	---	---	---
U-238	1.4E+01	1.6E+00	2.8E-01	3.4E-02	---	---
Pit 17						
Ac-227	4.2E-01	7.0E-02	---	---	---	---
Pit 18						
Am-241	1.4E+01	2.7E-04	4.0E-01	2.0E-03	1.2E+02	3.3E-01
C-14	3.9E+00	2.0E-06	---	---	---	---
Co-60	4.6E+01	1.1E+03	3.0E-02	1.6E-07	3.0E-02	1.6E-07
Cs-137	3.1E+01	1.6E-01	---	---	---	---
Eu-154	3.1E+01	5.2E-06	---	---	---	---
H-3	4.0E+01	1.0E+01	7.1E+00	2.8E-07	7.1E+00	2.8E-07
Kr-85	3.1E+01	1.5E-01	---	---	---	---
Pu-238	6.3E+02	1.4E-03	5.0E-02	1.3E-08	1.2E+02	1.2E+00
Pu-239	6.4E+02	3.1E-02	6.6E+00	6.1E-03	1.2E+02	9.7E-01
Pu-240	6.0E+02	2.0E-03	---	---	---	---
Pu-241	6.0E+02	3.1E-02	---	---	---	---
Pu-242	6.0E+02	1.2E-07	---	---	---	---
Sm-151	3.1E+01	5.8E-07	---	---	---	---
Sn-121m	3.1E+01	6.0E-05	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Sn-126	3.1E+01	1.5E-05	---	---	---	---
Sr-90	3.9E+01	1.2E+00	---	---	---	---
Th-232	1.9E+00	8.7E-04	---	---	---	---
U-234	5.0E+00	9.7E-02	3.4E-02	5.8E-02	---	---
U-235	8.9E+01	1.3E-02	1.4E+00	2.2E-03	1.4E+00	2.5E-10
U-236	2.3E+00	5.3E-06	---	---	---	---
U-238	4.0E+01	1.8E+00	1.5E-01	5.8E-01	---	---
Pit 19						
Cs-137	3.4E-02	4.1E-02	---	---	---	---
Eu-154	3.4E-02	1.3E-06	---	---	---	---
Kr-85	3.4E-02	3.8E-02	---	---	---	---
Sm-151	3.4E-02	1.4E-07	---	---	---	---
Sn-121m	3.4E-02	1.5E-05	---	---	---	---
Sn-126	3.4E-02	3.7E-06	---	---	---	---
Sr-90	3.4E-02	4.5E-02	---	---	---	---
Pit 20						
Am-241	---	---	---	---	1.9E+00	1.0E-01
Cf-249	5.7E-01	4.1E-04	---	---	---	---
Cf-251	8.5E-02	1.6E-03	---	---	---	---
Cs-137	6.3E+00	8.8E-03	---	---	---	---
Eu-154	6.3E+00	2.8E-07	---	---	---	---
H-3	2.1E+00	6.0E-01	---	---	---	---
Kr-85	6.3E+00	8.1E-03	---	---	---	---
Pu-238	3.6E+02	1.2E-01	---	---	1.9E+02	4.2E+00
Pu-239	2.5E+02	6.5E-01	---	---	1.9E+02	5.8E-01
Pu-240	2.4E+02	5.6E-04	---	---	---	---
Pu-241	2.4E+02	8.5E-03	---	---	---	---
Pu-242	2.4E+02	3.3E-08	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits,
1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)
Sm-151	6.3E+00	3.1E-08	---	---	---	---
Sn-121m	6.3E+00	3.3E-06	---	---	---	---
Sn-126	6.3E+00	8.1E-07	---	---	---	---
Sr-90	6.3E+00	9.7E-03	---	---	---	---
U-235	---	---	---	---	1.9E+00	4.7E-04
Pit 21						
U-234	1.8E+00	1.0E-01	---	---	---	---
U-235	5.1E+01	1.7E-01	---	---	---	---
U-238	1.9E+00	2.7E-01	---	---	---	---
Pit 22						
Am-241	2.1E-01	3.4E-03	---	---	7.4E+01	1.7E-01
Co-60	3.6E+01	1.1E-02	---	---	---	---
Cs-137	1.8E+01	8.2E+01	---	---	---	---
Eu-154	1.8E+01	2.6E-03	---	---	---	---
H-3	2.1E-01	5.0E-05	---	---	---	---
Kr-85	1.8E+01	7.5E+01	---	---	---	---
Pu-238	5.8E+01	6.4E-03	---	---	7.9E+01	4.5E-01
Pu-239	6.6E+01	9.4E-01	---	---	7.9E+01	4.1E-01
Pu-240	5.0E+01	1.2E-03	---	---	---	---
Pu-241	5.0E+01	1.9E-02	---	---	---	---
Pu-242	5.0E+01	7.2E-08	---	---	---	---
Sm-151	1.8E+01	2.9E-04	---	---	---	---
Sn-121m	1.8E+01	3.0E-02	---	---	---	---
Sn-126	1.8E+01	7.4E-03	---	---	---	---
Sr-90	1.8E+01	8.9E+01	---	---	---	---
U-234	---	---	1.7E-02	4.9E-02	---	---
U-235	2.7E+01	5.8E-04	1.7E-02	1.9E-03	---	---
U-238	1.7E+01	4.7E-01	2.4E+01	1.3E-01	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits,
1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pit 24						
Co-60	1.1E+02	2.9E-02	1.1E-01	1.6E-04	1.1E-01	1.6E-04
Cs-137	7.6E-01	1.5E-01	---	---	---	---
H-3	1.1E+01	5.0E-01	---	---	---	---
Sr-90	7.6E-01	1.7E-01	---	---	---	---
Th-230	1.1E-02	9.5E+00	---	---	---	---
Th-232	5.7E-02	3.3E-04	2.8E-03	1.1E-04	---	---
U-234	1.9E+01	7.8E-01	8.5E-03	6.7E-02	---	---
U-235	3.1E+01	3.2E-02	8.5E-03	2.6E-03	---	---
U-236	2.2E+00	3.1E-06	---	---	---	---
U-238	1.9E+01	2.2E+00	6.9E-01	2.0E-01	---	---
Pit 25						
Am-241	2.4E+00	3.1E-03	---	---	---	---
Co-60	8.1E+01	1.2E+02	---	---	---	---
Cs-137	3.7E+02	2.0E+02	7.1E+00	1.0E-09	---	---
Eu-154	6.4E+01	5.2E-06	---	---	---	---
H-3	2.4E+01	5.0E+01	---	---	---	---
Kr-85	6.4E+01	1.5E-01	---	---	---	---
Pu-238	2.1E+02	1.6E-03	---	---	---	---
Pu-239	6.0E+02	5.5E-02	---	---	---	---
Pu-240	1.9E+02	4.6E-04	---	---	---	---
Pu-241	1.9E+02	7.0E-03	---	---	---	---
Pu-242	1.9E+02	2.7E-08	---	---	---	---
Sm-151	6.4E+01	5.8E-07	---	---	---	---
Sn-121m	6.4E+01	6.0E-05	---	---	---	---
Sn-126	6.4E+01	1.5E-05	---	---	---	---
Sr-90	3.9E+02	1.9E-01	1.6E+01	4.0E-03	---	---
U-234	---	---	2.5E-02	2.8E-02	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
Radionuclide by Pit	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
U-235	7.3E+01	9.9E-03	2.3E+01	1.1E-03	---	---
U-238	4.6E+01	1.0E+00	6.5E-02	2.8E-01	---	---
Pit 26						
Am-241	9.6E+01	8.2E-04	---	---	1.9E+02	1.4E+01
Co-60	1.3E+02	4.2E+00	---	---	---	---
Cs-137	---	---	---	---	1.8E+02	7.7E-02
Eu-154	---	---	---	---	1.8E+02	2.5E-06
H-3	1.5E+01	3.0E-03	---	---	---	---
Kr-85	---	---	---	---	1.8E+02	7.1E-02
Pu-238	1.1E+02	3.4E-03	2.4E+01	7.6E-02	1.9E+02	7.4E-01
Pu-239	3.0E+02	1.7E-02	6.8E+01	1.6E+00	2.0E+02	1.1E+00
Pu-240	1.1E+02	8.2E-04	2.1E+01	1.3E-02	---	---
Pu-241	1.1E+02	1.2E-02	2.1E+01	2.0E-01	---	---
Pu-242	1.1E+02	4.7E-08	2.1E+01	7.4E-07	---	---
Sm-151	---	---	---	---	1.8E+02	2.7E-07
Sn-121m	---	---	---	---	1.8E+02	2.8E-05
Sn-126	---	---	---	---	1.8E+02	7.0E-06
Sr-90	1.0E+02	8.2E-03	5.1E+02	9.3E-02	2.3E+02	8.6E-02
U-235	2.4E+01	1.5E-01	---	---	6.7E+00	7.5E-04
U-238	1.5E+00	1.1E-01	2.5E+01	1.2E-03	---	---
Pit 27						
Am-241	2.3E+01	8.4E-08	3.3E+01	8.5E-06	6.8E+00	1.1E-09
Co-60	7.8E+01	2.7E+00	---	---	---	---
Cs-137	1.8E+02	2.8E-03	5.3E+00	1.5E-03	2.5E-01	5.3E-07
Eu-154	6.6E+01	8.9E-08	5.3E+00	1.4E-07	2.5E-01	4.9E-11
H-3	1.7E+01	1.1E+02	3.8E-01	2.5E-04	3.8E-01	2.5E-04
Kr-85	6.6E+01	2.6E-03	5.3E+00	1.4E-03	2.5E-01	4.8E-07
Pu-238	2.5E+02	4.9E-02	8.8E+00	4.8E-04	7.5E-01	2.1E-04

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits,
1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-239	4.7E+02	2.0E-02	1.7E+03	5.5E-01	3.6E+01	5.8E-03
Pu-240	2.2E+02	6.7E-04	---	---	---	---
Pu-241	2.2E+02	1.0E-02	---	---	---	---
Pu-242	2.2E+02	3.9E-08	---	---	---	---
Ra-226	1.5E+00	9.7E-02	---	---	---	---
Sm-151	6.6E+01	9.9E-09	5.3E+00	5.4E-09	2.5E-01	1.9E-12
Sn-121m	6.6E+01	1.0E-06	5.3E+00	5.6E-07	2.5E-01	1.9E-10
Sn-126	6.6E+01	2.5E-07	5.3E+00	1.4E-07	2.5E-01	4.8E-11
Sr-90	1.9E+02	3.4E-03	4.5E+02	3.2E-03	2.8E+00	1.8E-04
U-234	1.9E+01	1.9E-03	1.7E-02	4.5E-02	---	---
U-235	4.0E+01	6.1E-03	6.2E+00	1.8E-03	---	---
U-236	1.9E+01	9.5E-06	---	---	---	---
U-238	2.6E+01	4.8E-01	2.5E-02	3.8E-01	---	---
Pit 28						
Am-241	---	---	2.1E+01	3.0E-06	---	---
Co-60	3.4E+01	4.3E+00	---	---	---	---
H-3	1.1E+01	1.2E+03	---	---	---	---
Pu-238	1.8E+02	1.7E-01	1.5E+01	7.5E-02	1.5E+01	7.5E-02
Pu-239	4.9E+02	1.4E-01	5.4E+02	6.7E-02	1.2E+02	3.9E-02
Pu-240	1.5E+02	6.2E-04	---	---	---	---
Pu-241	1.5E+02	9.4E-03	---	---	---	---
Pu-242	1.5E+02	3.6E-08	---	---	---	---
Th-232	5.1E-01	2.3E-02	---	---	---	---
U-235	9.1E+00	8.0E-03	---	---	---	---
U-238	3.5E-01	6.6E-02	2.3E-01	4.5E-01	---	---
Pit 29						
Am-241	1.9E+02	6.3E-04	1.1E+02	1.2E+00	5.4E+01	2.0E+00
C-14	1.7E+00	2.1E-01	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Co-60	2.4E+02	1.7E-01	2.1E+02	1.6E-03	1.4E+00	8.3E-06
Cs-137	4.4E+01	8.8E+02	5.2E+02	3.0E-03	1.1E+01	1.5E-03
Eu-154	1.8E+01	7.4E-05	---	---	8.4E+00	7.3E-10
H-3	1.0E+02	5.8E-01	---	---	---	---
Kr-85	1.8E+01	2.2E+00	---	---	8.4E+00	2.1E-05
Np-237	8.5E-01	7.0E-07	---	---	---	---
Pu-238	3.8E+02	5.6E-02	1.9E+02	1.1E+00	7.4E+01	3.5E-01
Pu-239	6.6E+02	2.3E-01	3.1E+02	1.9E-03	7.7E+01	4.9E-01
Pu-240	3.3E+02	3.5E-02	1.5E+01	8.4E-04	1.5E+01	8.4E-04
Pu-241	3.4E+02	5.6E-01	1.5E+01	2.7E-02	1.5E+01	2.7E-02
Pu-242	3.3E+02	2.6E-06	1.5E+01	2.8E-07	1.5E+01	2.8E-07
Sm-151	1.8E+01	8.3E-06	---	---	8.4E+00	8.1E-11
Sn-121m	1.8E+01	8.7E-04	---	---	8.4E+00	8.5E-09
Sn-126	1.8E+01	2.1E-04	---	---	8.4E+00	2.1E-09
Sr-90	3.1E+01	1.4E+03	3.3E+02	8.9E-02	8.4E+00	2.5E-05
Th-232	1.9E-03	4.9E-05	---	---	---	---
U-233	3.4E-01	1.9E-02	---	---	---	---
U-234	1.1E+01	3.9E-02	---	---	---	---
U-235	4.5E+01	2.4E-01	---	---	2.4E+01	5.3E-03
U-236	1.1E+01	4.5E-05	---	---	---	---
U-238	5.1E+01	1.4E-01	5.6E+02	7.8E-01	2.5E+00	3.1E-05
Pit 32						
Am-241	1.3E+02	6.0E-02	1.7E+00	3.0E-03	1.3E+02	2.1E+00
C-14	4.3E-01	1.5E-06	---	---	---	---
Co-60	4.4E+02	3.3E-01	2.7E+00	3.3E-01	2.5E+00	3.3E-05
Cs-137	2.6E+01	3.0E-01	3.3E+02	2.1E-03	---	---
Eu-154	2.6E+01	9.3E-06	---	---	---	---
H-3	1.1E+02	1.5E+00	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Kr-85	2.6E+01	2.7E-01	---	---	---	---
Pu-238	2.1E+02	2.2E-02	3.8E+00	1.5E-04	1.3E+02	1.5E+00
Pu-239	4.1E+02	1.3E-01	2.9E+02	7.3E-02	1.3E+02	3.4E+00
Pu-240	2.1E+02	6.8E-03	3.8E+00	7.4E-04	3.6E+00	7.2E-04
Pu-241	2.1E+02	1.1E-01	3.6E+00	1.3E-02	3.6E+00	1.3E-02
Pu-242	2.1E+02	4.7E-07	3.6E+00	8.1E-08	3.6E+00	8.1E-08
Ra-226	1.3E-01	1.0E-05	---	---	---	---
Sm-151	2.6E+01	1.0E-06	---	---	---	---
Sn-121m	2.6E+01	1.1E-04	---	---	---	---
Sn-126	2.6E+01	2.7E-05	---	---	---	---
Sr-90	2.6E+01	3.2E-01	2.6E-01	3.1E-04	5.7E-02	2.8E-04
Th-230	4.2E-02	2.6E-09	---	---	---	---
Th-232	1.4E-01	1.0E-09	---	---	---	---
U-234	6.1E+00	2.1E-02	---	---	---	---
U-235	3.4E+01	3.5E-03	---	---	1.9E+00	3.2E-05
U-236	5.9E+00	6.8E-05	---	---	---	---
U-238	5.0E+01	4.1E-01	1.1E+00	3.4E-03	---	---
Pit 33						
Am-241	1.0E+02	9.5E-01	---	---	7.2E+01	9.7E-01
C-14	2.6E-01	1.5E-02	---	---	---	---
Co-60	1.7E+02	1.0E+00	3.6E-01	8.3E-06	3.6E-01	8.3E-06
Cs-137	2.2E+01	3.2E+00	1.1E-01	5.0E-07		
Eu-154	2.1E+01	5.4E-05	---	---	---	---
H-3	4.9E+01	4.0E+00	2.2E+01	5.9E-03	5.1E+00	2.6E-03
Kr-85	2.1E+01	1.6E+00	---	---	---	---
Pu-238	3.6E+02	1.7E-02	1.0E+00	6.0E-06	7.2E+01	4.4E-02
Pu-239	5.8E+02	1.4E+00	1.3E+02	5.4E-01	8.9E+01	2.5E-01
Pu-240	3.5E+02	5.5E-03	---	---	---	---

--- = None

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-241	3.5E+02	8.4E-02	---	---	---	---
Pu-242	3.5E+02	3.2E-07	---	---	---	---
Ra-228	1.4E-01	2.1E-01	---	---	---	---
Sm-151	2.1E+01	6.0E-06	---	---	---	---
Sn-121m	2.1E+01	6.3E-04	---	---	---	---
Sn-126	2.1E+01	1.5E-04	---	---	---	---
Sr-90	2.2E+01	2.0E+00	1.0E+00	1.2E-05	---	---
Th-232	2.3E-02	2.6E-03	---	---	---	---
U-234			5.7E-03	6.3E-04	---	---
U-235	5.1E+01	1.1E-02	1.9E+01	2.5E-05	2.6E+01	1.3E-05
U-238	3.3E+01	6.2E-01	3.3E+02	1.5E-01	1.4E+01	2.0E-05
Pit 35						
Am-241	4.5E+01	7.5E-05	---	---	2.8E+01	4.3E-01
Co-60	2.5E+02	2.2E+00	2.2E+01	6.6E-05	2.5E+00	8.2E-09
Cs-137	1.7E+01	1.2E+00	---	---	---	---
Eu-154	1.7E+01	3.7E-05	---	---	---	---
H-3	2.4E+01	1.2E+00	---	---	---	---
Kr-85	1.7E+01	1.1E+00	---	---	---	---
Pu-238	1.1E+02	4.3E-04	2.0E+01	2.8E-03	2.8E+01	3.1E-01
Pu-239	1.9E+02	3.3E-02	2.0E+01	9.6E-02	2.8E+01	9.1E-01
Pu-240	1.0E+02	2.4E-03	2.0E+01	2.2E-02	---	---
Pu-241	1.0E+02	3.7E-02	2.0E+01	3.4E-01	---	---
Pu-242	1.0E+02	1.4E-07	2.0E+01	1.3E-06	---	---
Sm-151	1.7E+01	4.2E-06	---	---	---	---
Sn-121m	1.7E+01	4.3E-04	---	---	---	---
Sn-126	1.7E+01	1.1E-04	---	---	---	---
Sr-90	1.7E+01	1.3E+00	---	---	---	---
U-235	7.4E-01	1.2E-03	---	---	---	---

--- = *None*

Table 25 (Continued)
Radionuclide Inventories Disposed of in Pits, 1971 through September 26, 1988

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
U-238	1.2E+01	5.7E-02	7.1E+00	1.0E-01	---	---
Pit 36						
Am-241	5.0E+01	8.7E-05	---	---	1.3E+01	1.3E-01
Co-60	3.8E+02	1.3E-01	---	---	---	---
Cs-137	3.6E+01	1.7E-01	---	---	---	---
Eu-154	3.6E+01	5.3E-06	---	---	---	---
H-3	2.7E+01	3.0E+01	---	---	---	---
Kr-85	3.6E+01	1.5E-01	---	---	---	---
Nb-94	5.3E-01	8.0E-06	---	---	---	---
Pu-238	1.1E+02	2.6E-02	4.8E+00	4.0E-04	1.3E+01	6.1E-02
Pu-239	1.8E+02	8.4E-02	1.2E+01	1.4E-02	1.3E+01	3.8E-01
Pu-240	1.1E+02	1.7E-02	4.8E+00	3.2E-03	---	---
Pu-241	1.1E+02	2.5E-01	4.8E+00	4.8E-02	---	---
Pu-242	1.1E+02	9.6E-07	5.2E+00	8.0E-06	---	---
Sm-151	3.6E+01	5.9E-07	---	---	---	---
Sn-121m	3.6E+01	6.2E-05	---	---	---	---
Sn-126	3.6E+01	1.5E-05	---	---	---	---
Sr-90	3.6E+01	1.8E-01	---	---	---	---
U-234	2.3E+00	7.9E-04	---	---	---	---
U-235	2.0E+02	4.8E-02	8.3E+00	5.7E-07	8.3E+00	5.7E-07
U-236	2.3E+00	3.4E-06	---	---	---	---
U-238	3.8E+01	3.1E-03	3.6E+01	1.5E-06	3.7E+00	2.9E-07

--- = *None*

Table 26
Radionuclide Inventories Disposed of in Shafts, 1971 through September 26, 1988

Radionuclide	Waste Form					
	Surface-Contaminated Waste [a]		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Am-241	1.5E+00	4.0E-02	---	---	---	---
Am-243	1.5E-02	1.1E-05	---	---	---	---
C-14	9.7E-01	1.1E+00	---	---	---	---
Cf-252	2.2E-01	5.5E+01	---	---	---	---
Cm-244	3.6E-01	1.9E-01	---	---	---	---
Co-60	2.4E+02	3.3E+03	---	---	---	---
Cs-137	1.6E+01	1.1E+03	---	---	---	---
Eu-154	1.5E+01	3.2E-02	---	---	---	---
H-3	7.9E+01	8.0E+05	1.0E-01	1.0E+02	1.0E-01	1.0E+02
Kr-85	1.7E+01	9.3E+02	---	---	---	---
Ni-63	3.8E+00	4.3E-03	---	---	---	---
Np-237	4.9E-02	7.8E-05	---	---	---	---
Pu-238	4.5E+01	1.4E+00	---	---	---	---
Pu-239	4.6E+01	9.8E+01	---	---	---	---
Pu-240	2.1E+00	3.7E+00	---	---	---	---
Pu-241	2.7E+00	5.6E+01	---	---	---	---
Pu-242	2.7E+00	2.1E-04	---	---	---	---
Ra-226	1.4E+00	2.5E+00	---	---	---	---
Sm-151	1.5E+01	3.6E-03	---	---	---	---
Sn-121m	1.5E+01	3.7E-01	---	---	---	---
Sn-126	1.5E+01	9.2E-02	---	---	---	---
Sr-90	1.6E+01	1.1E+03	---	---	---	---
Th-232	8.9E+00	1.9E-02	---	---	---	---
U-232	3.8E-03	2.1E-01	---	---	---	---
U-233	3.8E-01	4.0E+00	---	---	---	---
U-234	2.4E+01	4.7E-01	2.3E-01	2.8E-02	---	---
U-235	4.1E+01	1.0E+00	2.3E-01	1.1E-03	---	---
U-236	4.1E-01	1.9E-04	---	---	---	---
U-238	9.8E+01	1.1E+01	7.2E-01	1.8E-01	---	---

Table 27
Volumes and Activities of Transuranic Waste Disposed of in Pits and Shafts, 1971 through September 26, 1988

Disposal Unit and Waste Form	Disposal Volume (m³)	Disposal Activity (Ci)
Pit 6 — Concrete and Sludge	1.9E+01	6.0E+01
Pit 7 — Concrete and Sludge	1.9E+00	6.5E-02
Pit 8 — Concrete and Sludge	5.8E+01	7.1E+00
Pit 20 — Surface-Contaminated Waste	8.5E-02	1.6E-03
Pit 22 — Surface-Contaminated Waste	1.1E+01	6.0E+02
Shafts — Surface-Contaminated Waste	4.2E+00	2.8E+03

Table 28
Radionuclide Inventories in Transuranic Waste Disposed of in Pits and Shafts, 1971 through September 26, 1988

Radionuclide by Disposal Unit	Waste Form			
	Surface-Contaminated Waste		Concrete and Sludge	
	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)
Pit 6				
Pu-238	---	---	1.9E+01	5.6E+01
Pu-239	---	---	1.9E+01	3.6E+00
Pit 7				
Pu-238	---	---	1.9E+00	6.2E-02
Pu-239	---	---	1.9E+00	3.8E-03
U-235	---	---	1.9E+00	5.6E-05
Pit 8				
Am-241	---	---	4.2E+01	9.3E-01
Pu-238	---	---	5.5E+01	3.6E+00
Pu-239	---	---	5.8E+01	2.6E+00
Pit 20				
Cf-251	8.5E-02	1.6E-03	---	---
Pit 22				
Am-241	2.1E-01	3.4E-03	---	---
Cs-137	1.1E+01	8.2E+01	---	---
Eu-154	1.1E+01	2.6E-03	---	---
Kr-85	1.1E+01	7.5E+01	---	---

--- = *None*

Table 28 (Continued)
Radionuclide Inventories of Transuranic Waste Disposed of in Pits and Shafts, 1971 through September 26, 1988

Radionuclide by Disposal Unit	Waste Form			
	Surface-Contaminated Waste		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-239	1.1E+01	9.3E-01	---	---
Sm-151	1.1E+01	2.9E-04	---	---
Sn-121m	1.1E+01	3.0E-02	---	---
Sn-126	1.1E+01	7.4E-03	---	---
Sr-90	1.1E+01	8.9E+01	---	---
U-235	1.1E+01	1.1E-04	---	---
Shafts				
Am-241	2.8E-02	3.4E-03	---	---
Cm-244	1.9E-03	2.3E-04	---	---
Cs-137	1.9E+00	3.6E+02	---	---
Eu-154	1.9E+00	1.1E-02	---	---
Kr-85	1.9E+00	3.3E+02	---	---
Np-237	4.5E-02	7.1E-06	---	---
Pb-210	1.7E-01	9.9E-04	---	---
Pu-238	2.1E+00	6.3E-01	---	---
Pu-239	4.3E+00	9.7E+01	---	---
Pu-240	1.9E+00	3.7E+00	---	---
Pu-241	1.9E+00	5.6E+01	---	---
Pu-242	1.9E+00	2.1E-04	---	---
Sm-151	1.9E+00	1.3E-03	---	---
Sn-121m	1.9E+00	1.3E-01	---	---
Sn-126	1.9E+00	3.2E-02	---	---
Sr-90	1.9E+00	3.9E+02	---	---
U-233	4.5E-02	9.7E-04	---	---
U-234	6.8E-02	2.1E-02	---	---
U-235	1.4E+00	5.8E-03	---	---
U-236	1.1E-02	8.9E-05	---	---
U-238	1.1E-01	2.1E-03	---	---

--- = None

Table 29
Volumes and Activities of Waste Disposed of in Pits and Shafts, September 27, 1988 through 2003

Waste Form by Disposal Unit	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit 15		
Surface-Contaminated Waste	3.2E+03	2.0E+02
Soil	2.2E+02	3.6E+00
Concrete and Sludge	1.8E+02	2.8E+00
Pit 30		
Surface-Contaminated Waste	8.8E+03	3.4E+01
Soil	9.4E+02	2.3E+00
Concrete and Sludge	3.7E+02	6.9E-01
Pit 31		
Surface-Contaminated Waste	4.8E+02	2.2E-01
Soil	1.5E+03	5.6E-01
Concrete and Sludge	1.4E+02	4.3E-02
Pit 36		
Surface-Contaminated Waste	9.1E+02	1.6E+00
Soil	7.3E+01	1.5E-01
Concrete and Sludge	5.9E+01	1.5E-01
Pit 37		
Surface-Contaminated Waste	1.4E+04	4.4E+02
Soil	3.3E+03	3.6E+00
Concrete and Sludge	7.0E+02	1.8E+00
Pit 38		
Surface-Contaminated Waste	6.4E+03	2.9E+02
Soil	1.8E+03	6.3E+00
Concrete and Sludge	7.9E+02	1.5E+01
Pit 39		
Surface-Contaminated Waste	4.2E+03	1.4E+01
Soil	9.7E+03	6.1E+00
Concrete and Sludge	5.6E+02	2.4E+00
Shafts		
Surface-Contaminated Waste	3.9E+02	1.4E+06
Soil	9.9E+00	2.0E+02
Concrete and Sludge	2.6E+01	2.0E+02

The radionuclide-specific inventories in the September 27, 1988 through 2003 waste are listed in Tables 30 and 31 for the pits and shafts, respectively. Inventories are provided for each pit, but are summed over all of the shafts. Volumes provided in the tables represent the quantities of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of the waste package volumes is greater than the total volume of waste disposed of in the pits and shafts. The listed activities represent as-disposed activities, and include all contributions from MAP and MFP waste and the material types discussed in Section 3.1. The listed inventories do not include the radionuclides that were eliminated on the basis of their decay characteristics as described in *Attachment I*.

4.2 Future Inventory Projections

Table 32 provides the future inventory projections for MDA G, addressing the waste that is expected to require disposal from 2004–2044. Total volumes and activities are summarized by waste form; separate inventories are provided for pits and shafts. The table shows contributions made to the inventory by the extrapolated volumes and activities, tritium waste, uranium chips and turnings, and soil excavated from TA-50. Corresponding radionuclide-specific pit and shaft inventories are provided in Tables 33 and 34, respectively. Volumes provided in these tables represent the quantities of waste expected to be contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of the waste package volumes is greater than the total volume of waste disposed of in the pits and shafts. The listed activities represent as-disposed activities, and include all contributions from MAP and MFP waste, and the material types discussed in Section 3.1. The listed inventories do not include the radionuclides that were eliminated on the basis of their decay characteristics (see *Attachment I*).

The quantities of tritium waste that are expected to be generated by the completion of cleanup activities at the TSFF are summarized in Table 35. This information does not address contaminated equipment that is expected to be shipped to MDA G within the next few years, nor does it address the waste generated by the eventual D&D of the facility. It is unclear at this time what quantities of waste will be generated by these activities. The information used to estimate the quantities of tritium waste that will be shipped to MDA G for disposal by the WETF is summarized in Table 36. The stainless steel overpack included for this facility in 2004 is being shipped for disposal via the TSFF and is included in the information provided in Table 35.

Table 37 presents future inventories of tritium waste estimated on the basis of the information included in Tables 35 and 36. In developing these projections it was assumed that the TSFF will ship the maximum number of each type of container included in Table 35 for the maximum number of years listed. The stainless steel overpacks generated by this facility were assumed to contain an average of 6.8×10^4 Ci of tritium. All low-activity waste was assumed to be placed in the disposal pits, while all high-activity waste was assumed to be disposed of in shafts. Finally, all of the tritium waste was assigned to the surface-contaminated waste form.

Table 30
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pit 15						
Ag-108m	1.0E+01	1.1E-04	---	---	---	---
Am-241	1.5E+03	1.6E-01	5.1E+01	2.3E-03	4.0E+01	1.9E-03
Am-243	2.4E+01	1.1E-05	6.4E-01	7.7E-07	6.4E-01	7.7E-07
Ba-133	1.3E+01	6.2E-06	---	---	---	---
C-14	6.6E+00	5.2E-07	---	---	---	---
Cf-249	2.7E+00	4.3E-07	---	---	---	---
Cm-243	4.0E+00	6.8E-07	6.7E-01	2.0E-08	6.7E-01	2.0E-08
Co-60	4.2E+02	2.3E+00	1.9E+01	7.0E-02	1.9E+01	7.0E-02
Cs-135	1.8E+00	5.9E-07	---	---	---	---
Cs-137	5.9E+02	3.1E-01	5.7E+01	7.0E-01	2.5E+01	6.8E-05
Eu-152	1.1E+01	2.7E-03	---	---	---	---
Eu-154	2.8E+00	2.1E-06	---	---	---	---
H-3	1.6E+02	1.5E+02	2.8E+01	5.5E-03		
Ho-166m	2.5E+00	6.2E-06	---	---	---	---
I-129	2.3E-01	1.0E-06	---	---	---	---
K-40	7.1E+01	1.4E-04	1.1E+01	1.1E-04	1.0E+01	7.1E-05
Kr-85	1.0E-01	1.1E-06	5.2E-02	5.4E-07	5.2E-02	5.4E-07
Nb-94	8.5E-01	1.7E-05	---	---	---	---
Ni-59	2.3E-01	6.1E-06	---	---	---	---
Ni-63	3.1E+00	5.5E-04	---	---	---	---
Np-237	1.1E+02	1.1E-04	1.3E+00	9.6E-08	1.3E+00	9.6E-08
Pa-231	2.3E-01	1.0E-09	---	---	---	---
Pb-210	5.1E+01	1.6E-01	---	---	---	---
Pu-238	1.2E+03	1.2E+00	3.0E+01	2.3E-02	2.6E+01	2.3E-02
Pu-239	2.1E+03	8.9E-01	1.5E+02	3.6E-02	1.4E+02	3.2E-02
Pu-240	4.4E+02	6.4E-02	1.0E+01	5.0E-03	---	---

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-241	4.5E+02	1.2E+00	---	---	---	---
Pu-242	3.6E+02	5.1E-04	---	---	---	---
Ra-226	7.1E+01	2.1E-03	9.9E+00	1.1E-05	8.7E+00	9.1E-06
Ra-228	1.6E+01	9.3E-05	8.0E+00	4.7E-05	8.0E+00	4.7E-05
Si-32	4.0E-01	1.2E-05	---	---	---	---
Sr-90	8.0E+01	2.9E-02	3.0E+01	2.2E-02	---	---
Tb-157	5.6E+00	4.5E-08	---	---	---	---
Tc-99	1.8E+01	9.9E-03	---	---	---	---
Th-228	9.2E+00	4.9E-04	1.3E+00	2.0E-06	1.3E+00	2.0E-06
Th-229	9.3E+00	6.9E-05	---	---	---	---
Th-230	3.4E+00	2.2E-08	---	---	---	---
Th-232	1.5E+02	8.1E-03	1.1E+01	4.0E-03	1.1E+01	4.0E-03
Ti-44	8.5E+00	3.8E-04	---	---	---	---
U-232	3.0E+00	1.8E-08	---	---	---	---
U-233	1.1E+01	7.5E-03	---	---	---	---
U-234	2.0E+02	1.5E-01	1.2E+01	8.3E-04	9.6E+00	7.4E-04
U-235	9.9E+02	1.6E-02	3.1E+01	5.2E-05	3.0E+01	3.9E-05
U-236	5.6E+01	3.2E-05	---	---	---	---
U-238	7.6E+02	5.6E+00	2.2E+01	3.2E-03	2.0E+01	2.4E-03
Zr-93	1.1E-01	2.0E-08	---	---	---	---
Pit 30						
Am-241	5.9E+02	2.7E-02	1.6E+01	2.6E-07	4.8E+00	2.3E-04
C-14	1.6E+00	2.0E-09	---	---	---	---
Co-60	2.1E+03	6.5E-01	2.1E+02	1.8E-01	1.1E+02	1.8E-01
Cs-137	7.5E+02	3.2E+00	1.4E+02	4.1E-01	1.3E+02	4.1E-01
Eu-154	3.8E+02	7.3E-05	1.3E+01	5.1E-09	3.3E+00	3.4E-09
H-3	1.2E+02	8.6E-01	6.2E-01	7.2E-04	---	---
Kr-85	3.9E+02	2.2E+00	1.3E+01	1.5E-04	3.3E+00	9.8E-05
Ni-63	8.5E-02	1.0E-05	---	---	---	---

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-238	5.1E+02	2.4E-02	3.0E+01	1.6E+00	2.1E-01	9.1E-04
Pu-239	1.4E+03	2.7E-01	3.9E+01	2.7E-03	2.7E+01	3.0E-03
Pu-240	5.0E+02	2.9E-02	---	---	---	---
Pu-241	5.0E+02	4.3E-01	---	---	---	---
Pu-242	5.0E+02	1.7E-06	---	---	---	---
Ra-226	1.3E+01	1.0E-03	---	---	---	---
Sm-151	3.8E+02	8.2E-06	1.3E+01	5.7E-10	3.3E+00	3.8E-10
Sn-121m	3.8E+02	8.5E-04	1.3E+01	5.9E-08	3.3E+00	3.9E-08
Sn-126	3.8E+02	2.1E-04	1.3E+01	1.5E-08	3.3E+00	9.7E-09
Sr-90	4.1E+02	2.6E+00	2.6E+01	3.3E-02	1.6E+01	3.3E-02
Tc-99	3.2E+00	8.3E-09	---	---	---	---
Th-228	5.7E+00	5.0E-07	2.8E+00	2.5E-07	2.8E+00	2.5E-07
Th-232	3.5E+00	3.7E-02	---	---	---	---
U-234	1.6E+01	2.9E-02	---	---	2.1E-01	5.1E-06
U-235	2.0E+02	4.1E-01	2.3E+01	5.5E-02	1.2E+01	5.5E-02
U-236	2.8E-02	1.2E-04	---	---	---	---
U-238	1.5E+02	3.5E+00	1.5E+01	3.5E-03	6.7E+00	2.5E-03
Pit 31						
Am-241	8.9E+00	5.2E-03	1.3E+03	1.2E-01	3.4E+00	3.2E-04
C-14	3.3E+00	3.4E-09	1.6E+00	1.7E-09	1.6E+00	1.7E-09
Co-60	5.2E+00	4.0E-07	1.6E+00	8.3E-10	1.6E+00	8.3E-10
Cs-137	1.9E+02	5.7E-03	1.4E+03	2.7E-01	5.6E+01	5.9E-05
Eu-154	5.2E+01	4.1E-11	2.6E+01	2.1E-11	2.6E+01	2.1E-11
H-3	9.1E+00	9.2E-03	4.5E+00	4.6E-03	4.5E+00	4.6E-03
K-40	1.1E+02	8.6E-04	2.0E+01	3.3E-04	2.0E+01	3.3E-04
Kr-85	5.2E+01	1.2E-06	2.6E+01	5.9E-07	2.6E+01	5.9E-07
Pu-238	1.3E+01	2.5E-02	1.3E+03	7.5E-03	4.0E+00	2.0E-03
Pu-239	9.9E+01	1.1E-01	1.3E+03	5.8E-02	6.4E+00	3.3E-02
Pu-240	2.9E+00	4.0E-03	---	---	---	---

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-241	2.9E+00	5.6E-02	---	---	---	---
Pu-242	2.9E+00	2.3E-07	---	---	---	---
Ra-226	4.2E+01	3.9E-04	2.1E+01	2.0E-04	2.1E+01	2.0E-04
Sm-151	5.3E+01	4.5E-10	2.6E+01	2.3E-10	2.6E+01	2.3E-10
Sn-121m	5.2E+01	4.8E-10	2.6E+01	2.4E-10	2.6E+01	2.4E-10
Sn-126	5.2E+01	1.2E-10	2.6E+01	5.9E-11	2.6E+01	5.9E-11
Sr-90	1.3E+02	1.7E-03	1.3E+03	9.5E-02	3.1E+01	4.0E-06
Tc-99	1.1E+01	4.8E-06	5.7E+00	2.4E-06	5.7E+00	2.4E-06
Th-228	4.2E-01	3.3E-07	---	---	---	---
Th-232	1.1E+01	1.7E-06	3.9E+00	6.5E-07	3.9E+00	6.5E-07
U-234	5.1E+01	9.9E-04	2.6E+01	4.9E-04	2.6E+01	4.9E-04
U-235	1.1E+02	3.1E-04	3.7E+01	1.5E-04	3.7E+01	1.5E-04
U-238	2.1E+01	2.6E-03	8.4E+00	1.3E-03	8.4E+00	1.3E-03
Pit 36						
Am-241	2.1E+01	1.2E-04	---	---	---	---
Co-60	1.3E+02	2.0E-01	2.8E+01	7.5E-02	2.8E+01	7.5E-02
Cs-137	5.7E+01	1.5E-01	2.8E+01	7.5E-02	2.8E+01	7.5E-02
Eu-152	2.1E+00	2.9E-02	---	---	---	---
Eu-154	7.9E-01	4.3E-08	---	---	---	---
H-3	1.4E+01	2.9E-01	---	---	---	---
Kr-85	7.9E-01	1.2E-03	---	---	---	---
Pu-238	3.0E+01	2.7E-04	---	---	---	---
Pu-239	2.0E+02	1.3E-02	---	---	---	---
Pu-240	3.0E+01	2.1E-03	---	---	---	---
Pu-241	3.0E+01	3.2E-02	---	---	---	---
Pu-242	3.0E+01	1.2E-07	---	---	---	---
Sm-151	7.9E-01	4.8E-09	---	---	---	---
Sn-121m	7.9E-01	5.0E-07	---	---	---	---
Sn-126	7.9E-01	1.2E-07	---	---	---	---

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Sr-90	7.9E-01	1.5E-03	---	---	---	---
U-235	1.3E+01	4.2E-09	---	---	---	---
U-238	7.8E+00	6.5E-02	---	---	---	---
Pit 37						
Ac-227	---	---	5.3E-02	3.7E-06	---	---
Al-26	3.8E-02	2.6E-04	---	---	---	---
Am-241	1.9E+03	1.2E-01	1.1E+03	1.9E-02	7.9E+01	1.8E-01
Am-243	2.3E+01	2.5E-05	1.7E-01	2.4E-07	1.7E-01	2.4E-07
Ba-133	7.6E-01	1.3E-03	---	---	---	---
Bi-207	7.4E-01	2.0E-05	---	---	---	---
Bk-247	8.2E+00	5.4E-08	---	---	---	---
C-14	6.0E+01	1.7E-02	7.4E+00	3.9E-05	7.4E+00	3.9E-05
Cf-252	1.4E-01	1.4E-05	---	---	---	---
Cl-36	2.0E-01	3.7E-04	---	---	---	---
Co-60	1.8E+03	7.0E+00	4.8E+01	5.0E-03	2.3E+01	9.8E-05
Cs-135	4.0E-01	7.0E-08	---	---	---	---
Cs-137	1.8E+03	2.6E-01	8.9E+02	2.3E-01	2.9E+02	1.4E-03
Eu-152	2.1E+00	3.1E-07	1.1E+00	2.7E-07	1.1E+00	5.0E-09
Eu-154	8.6E+02	3.6E-06	1.9E+02	1.9E-09	2.5E+00	5.5E-08
H-3	3.1E+02	3.0E+02	4.9E+02	2.8E+00	1.1E+01	2.5E-05
Ho-163	1.6E+01	8.3E-01	---	---	---	---
K-40	9.5E-03	8.8E-07	1.3E+02	1.1E-03	---	---
Kr-85	8.6E+02	7.6E-02	1.9E+02	5.6E-05	2.5E+00	1.6E-04
Nb-94	1.7E-01	2.5E-02	---	---	---	---
Ni-59	2.6E+01	2.1E-03	---	---	---	---
Ni-63	3.4E-01	5.6E-03	---	---	---	---
Np-237	3.0E+01	1.1E-05	3.4E-01	3.5E-08	3.4E-01	3.5E-08
Pa-231	3.1E+00	1.0E-08	---	---	---	---
Pb-210	1.1E-01	9.6E-03	---	---	---	---

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pm-145	2.0E+01	1.0E-01	---	---	---	---
Pu-238	1.4E+03	5.3E-02	1.0E+03	2.4E-03	7.1E+01	1.0E+00
Pu-239	2.3E+03	2.3E+00	1.2E+03	2.7E-01	1.1E+02	4.8E-01
Pu-240	1.3E+03	2.3E-01	1.5E+02	2.4E-03	2.6E+01	7.7E-04
Pu-241	1.1E+03	3.5E+00	9.2E-01	1.6E-07	9.2E-01	9.5E-13
Pu-242	1.0E+03	1.3E-05	9.2E-01	3.6E-18	9.2E-01	3.6E-18
Ra-226	2.1E+00	2.3E-02	2.8E+01	2.2E-04	---	---
Ra-228	1.4E-01	1.3E-09	---	---	---	---
Sm-151	8.6E+02	2.9E-07	1.9E+02	2.2E-10	2.5E+00	6.2E-10
Sn-121m	8.6E+02	3.0E-05	1.9E+02	2.3E-08	2.5E+00	6.4E-08
Sn-126	8.6E+02	7.5E-06	1.9E+02	5.6E-09	2.5E+00	1.6E-08
Sr-90	1.6E+03	1.6E-01	8.3E+02	4.6E-02	2.9E+02	3.9E-03
Tc-97	8.5E-01	2.1E-06	---	---	---	---
Tc-99	1.6E+02	9.9E-03	8.3E+00	2.6E-06	2.9E-01	8.3E-08
Th-227	---	---	5.3E-02	5.1E-08	---	---
Th-228	1.9E+01	1.1E-03	2.8E-01	8.2E-06	1.7E-01	8.1E-06
Th-229	1.4E+01	3.9E-05	1.7E-01	5.2E-07	1.7E-01	5.2E-07
Th-230	1.3E+01	4.3E-07	1.1E-01	6.3E-08	---	---
Th-232	6.1E+02	8.1E-03	3.2E+02	3.8E-03	2.7E+02	3.8E-03
Ti-44	7.6E+00	3.0E-05	---	---	---	---
U-232	4.2E-01	3.4E-05	---	---	---	---
U-233	1.2E+01	1.3E-03	2.0E+00	2.8E-04	2.0E+00	2.8E-04
U-234	1.2E+03	2.4E-01	4.4E+02	4.1E-03	3.3E+01	1.1E-03
U-235	2.1E+03	2.8E-01	4.6E+02	1.8E-03	1.2E+02	7.4E-04
U-236	2.5E+01	1.2E-04	5.8E+00	3.1E-06	5.8E+00	3.1E-06
U-238	1.2E+03	7.4E-01	9.0E+02	1.6E-01	2.9E+02	2.1E-02
Pit 38						
Ag-108m	1.3E+01	2.5E-07	---	---	---	---
Am-241	2.1E+03	2.1E+00	1.3E+03	1.2E-01	5.4E+02	3.3E+00

--- = None

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Am-243	1.2E+02	7.8E-03	2.7E+01	6.5E-05	1.8E+01	5.7E-05
Ba-133	5.8E+01	6.8E-03	---	---	---	---
Be-10	1.6E+01	4.6E-03	---	---	---	---
Bi-207	3.0E+00	6.3E-03	---	---	---	---
Bk-247	2.4E+01	2.3E-07	---	---	---	---
C-14	6.1E+01	3.3E+00	5.5E+00	2.2E-07	2.2E+01	7.4E-04
Ca-41	1.6E+01	2.7E-01	---	---	---	---
Cf-249	2.5E+00	2.9E-07	---	---	---	---
Cl-36	1.6E+01	1.8E-02	---	---	---	---
Cm-243	5.7E+00	3.1E-05	---	---	1.2E+01	1.0E-05
Cm-244	2.8E-01	1.0E-04	1.9E-02	2.2E-10	---	---
Cm-245	---	---	---	---	2.2E+01	4.6E-05
Co-60	9.2E+02	2.6E+01	1.5E+02	5.1E-01	1.4E+02	4.6E-01
Cs-135	4.0E+00	3.1E-05	---	---	---	---
Cs-137	1.0E+03	8.1E-01	6.6E+02	1.2E-01	8.0E+01	3.7E-01
Eu-152	1.7E+02	2.3E-01	3.4E+01	3.6E-02	2.7E+01	3.6E-02
Eu-154	1.5E+02	3.4E-02	2.2E+01	5.1E-03	1.9E+01	5.0E-03
H-3	7.8E+02	2.1E+02	7.7E+02	4.3E+00	1.3E+02	1.0E+00
Ho-163	9.4E+00	8.3E-02	---	---	---	---
Ho-166m	2.5E+00	5.5E-07	---	---	---	---
I-129	6.4E+00	1.6E-05	---	---	1.7E+01	9.8E-06
K-40	2.6E+01	5.0E-04	3.2E+01	1.0E-03	9.6E+00	1.1E-05
Kr-85	1.1E+01	2.9E-03	---	---	---	---
Lu-176	---	---	---	---	2.1E-01	1.7E-06
Mo-93	1.7E-01	2.0E-05	---	---	---	---
Nb-91	5.7E-02	5.0E-07	---	---	---	---
Nb-92	5.7E-02	3.0E-06	---	---	---	---
Nb-93m	1.6E+00	2.2E-05	6.9E-01	5.7E-09	6.9E-01	5.7E-09
Nb-94	5.6E+00	1.5E-02	1.4E+00	3.0E-08	1.4E+00	3.0E-08

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)
Ni-59	1.4E+01	1.7E-03	1.1E+00	2.2E-05	1.1E+00	2.2E-05
Ni-63	1.6E+02	1.9E+00	2.0E+01	1.1E-02	4.0E+01	1.3E-02
Np-237	1.1E+02	2.4E-03	4.8E+00	5.5E-06	1.6E+01	6.1E-06
Os-194	4.0E-01	1.3E-07	---	---	---	---
Pa-231	2.1E+00	5.3E-05	1.9E-02	4.7E-08	---	---
Pb-210	1.1E+01	3.0E-04	5.0E-04	7.2E-10	2.1E-01	2.5E-08
Pm-145	9.4E+00	1.0E-02	---	---	---	---
Pu-236	5.7E-02	1.0E-09	---	---	---	---
Pu-238	1.8E+03	2.6E+00	1.2E+03	1.5E-02	5.5E+02	4.1E+00
Pu-239	2.9E+03	4.3E+00	1.4E+03	1.5E-01	5.9E+02	4.6E+00
Pu-240	5.7E+02	1.3E-02	4.9E+02	4.7E-02	2.9E+01	3.3E-02
Pu-241	5.5E+02	4.1E-01	---	---	1.4E+01	8.4E-06
Pu-242	5.0E+02	1.6E-03	1.1E+01	6.5E-05	2.8E+00	5.8E-05
Pu-244	---	---	---	---	6.2E+00	3.5E-06
Ra-226	4.8E+01	7.6E-03	5.5E+01	2.2E-03	5.3E-01	1.1E-08
Ra-228	1.2E+01	5.7E-06	---	---	---	---
Si-32	1.5E-01	5.2E-07	---	---	---	---
Sm-151	1.8E+01	1.6E-09	---	---	---	---
Sr-90	2.3E+02	1.7E-01	7.0E+02	1.0E-01	2.1E+01	2.6E-03
Tc-97	1.1E-01	2.0E-08	---	---	---	---
Tc-99	1.3E+02	2.5E-01	1.3E+01	5.0E-04	2.3E+01	6.0E-04
Th-227	5.7E-01	5.2E-10	5.4E+01	6.6E-03	---	---
Th-228	8.2E+01	2.8E-04	6.1E+01	1.5E-04	1.1E+01	1.8E-05
Th-229	1.1E+01	2.7E-04	---	---	---	---
Th-230	4.4E+01	2.1E-05	5.4E+01	1.1E-03	5.6E+00	3.9E-06
Th-232	2.0E+02	5.0E-03	7.7E+01	8.0E-03	3.3E+01	4.7E-04
Ti-44	4.2E+01	2.9E-04	1.3E+00	9.9E-08	1.3E+00	9.9E-08
U-232	3.8E+00	1.4E-04	1.0E-01	5.7E-05	1.0E-01	5.7E-05
U-233	1.4E+01	1.8E-03	1.0E-01	5.7E-05	1.0E-01	5.7E-05

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
U-234	8.5E+02	8.0E-01	7.7E+02	3.5E-02	2.0E+02	4.5E-02
U-235	1.9E+03	4.2E-02	8.1E+02	2.4E-03	5.1E+02	5.3E-03
U-236	1.5E+02	1.9E-04	1.0E-01	5.7E-05	1.0E-01	5.7E-05
U-238	1.5E+03	1.9E+00	7.9E+02	7.7E-02	1.3E+02	9.2E-02
Pit 39						
Ag-108m	9.4E+00	4.9E-05	---	---	---	---
Am-241	9.5E+02	2.0E-01	3.2E+03	2.2E-01	8.7E+01	3.3E-01
Am-243	5.0E+01	1.3E-06	---	---	---	---
Ba-133	6.7E+00	1.6E-06	---	---	---	---
Bi-207	3.8E-03	7.4E-05	---	---	---	---
C-14	3.8E+01	4.8E-05	1.9E+00	4.0E-08		
Co-60	3.6E+02	3.9E+00	5.5E+03	2.1E+00	7.2E+01	4.3E-04
Cs-135	3.8E+01	1.0E-04	---	---	---	---
Cs-137	6.8E+02	6.6E-02	3.3E+03	1.4E-01	1.2E+01	1.5E-02
Eu-152	5.6E+01	1.0E-02	5.2E+03	2.2E-03	---	---
Eu-154	3.9E+01	1.2E-04	---	---	---	---
Gd-148	5.7E-02	1.0E-05	---	---	---	---
H-3	2.7E+02	1.6E+00	5.8E+03	2.5E+00	3.3E+00	1.5E-03
I-129	3.6E+01	1.1E-06	---	---	---	---
K-40	3.7E+01	2.7E-06	1.5E+01	2.3E-04	7.2E+00	7.0E-07
Kr-85	1.2E+00	5.7E-08	---	---	---	---
Nb-94	1.1E-01	1.0E-05	---	---	---	---
Nd-144	5.7E-02	1.0E-08	---	---	---	---
Ni-59	5.3E+01	2.4E-03	---	---	---	---
Ni-63	3.6E+01	5.1E-04	---	---	---	---
Np-237	8.7E+01	6.3E-04	---	---	---	---
Pa-231	3.4E-01	6.0E-12	8.0E+00	1.8E-05	---	---
Pb-210	3.4E+01	4.4E-02	5.7E+00	1.3E-02	5.7E+00	1.3E-02
Po-210	2.8E-03	4.9E-11	---	---	---	---

--- = *None*

Table 30 (Continued)
Radionuclide Inventories in Waste Disposed of in Pits, September 27, 1988 through 2003

Radionuclide by Pit	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-238	8.1E+02	3.1E-01	7.5E+03	1.7E-02	6.2E+01	1.5E+00
Pu-239	1.8E+03	4.9E-01	8.8E+03	5.3E-01	2.6E+02	5.1E-01
Pu-240	4.0E+02	4.1E-02	4.9E+02	2.3E-01	3.5E-01	3.9E-10
Pu-241	4.1E+02	7.3E-01	3.5E-01	5.9E-14	3.5E-01	5.9E-14
Pu-242	4.0E+02	7.7E-06	3.5E-01	2.4E-14	3.5E-01	2.4E-14
Ra-226	5.0E+01	5.9E-04	1.4E+01	2.1E-04	5.7E+00	1.7E-04
Ra-228	4.3E+00	3.4E-05	---	---	---	---
Si-32	1.1E-01	1.1E-07	---	---	---	---
Sr-90	1.4E+02	5.2E-03	8.1E+03	4.7E-02	---	---
Tc-97	4.0E-01	7.0E-09	---	---	---	---
Tc-99	1.5E+02	2.8E-02	6.4E+00	5.0E-13	6.4E+00	5.0E-13
Th-227	---	---	8.0E+00	6.0E-06	---	---
Th-228	1.8E+01	4.4E-05	5.7E-02	3.6E-09	---	---
Th-229	7.5E+00	4.8E-07	---	---	---	---
Th-230	2.5E+01	4.9E-07	5.7E-02	2.9E-08	---	---
Th-232	9.1E+01	1.4E-03	5.7E+00	1.9E-11	5.7E+00	1.9E-11
U-232	6.4E+00	5.2E-04	---	---	---	---
U-233	1.4E+01	5.4E-04	1.9E+00	9.5E-11	1.9E+00	9.5E-11
U-234	6.1E+02	2.8E-01	8.7E+02	5.4E-02	2.1E+02	5.6E-03
U-235	1.3E+03	1.7E-02	7.0E+02	2.3E-03	2.7E+02	1.2E-03
U-236	2.5E+00	1.0E-07	5.3E-02	1.2E-08	5.2E-02	1.1E-08
U-238	1.1E+03	8.1E-01	7.1E+02	1.3E-01	7.6E+01	2.2E-03

--- = *None*

Table 31
Radionuclide Inventories in Waste Disposed of in Shafts, September 27, 1988 through 2003

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ac-227	5.4E-04	5.3E-07	---	---	---	---
Ag-108m	1.5E+00	4.4E+00	---	---	---	---
Am-241	1.4E+01	3.3E-03	5.9E-01	8.9E-05	2.4E+01	6.9E-02
Am-243	3.0E-02	1.0E-09	1.4E-02	2.5E-19	1.4E-02	2.5E-19
Ba-133	3.1E-02	1.5E-03	---	---	---	---
Bi-207	1.2E-01	5.4E-05	---	---	---	---
C-14	1.8E+01	1.6E+01	---	---	---	---
Cf-252	4.7E-03	7.2E-08	---	---	---	---
Cl-36	5.4E-04	9.9E-09	---	---	---	---
Cm-244	1.9E-02	4.0E-09	---	---	---	---
Co-60	1.5E+02	3.0E+03	1.0E+00	8.5E+01	1.0E+00	8.5E+01
Cs-135	2.7E+00	4.5E-06	---	---	---	---
Cs-137	6.8E+00	9.1E+01	4.2E-01	7.4E-06	---	---
Eu-152	1.4E+00	2.3E-03	---	---	---	---
Eu-154	1.2E+00	9.7E-02	---	---	---	---
Gd-148	5.4E-04	7.7E-09	---	---	---	---
H-3	8.3E+01	1.3E+06	4.7E-01	1.1E-03	5.7E-02	1.1E-03
Ho-163	1.8E+00	7.0E-02	---	---	---	---
K-40	1.0E+00	4.3E-07	---	---	---	---
Kr-85	8.2E-01	7.5E+00	---	---	---	---
Mo-93	2.5E+01	1.1E-02	8.1E-01	1.1E-03	8.1E-01	1.1E-03
Nb-92	1.1E-01	4.0E-03	---	---	---	---
Ni-59	1.6E+00	1.3E+00	8.1E-01	6.3E-01	8.1E-01	6.3E-01
Ni-63	4.1E+01	9.9E+02	8.1E-01	7.2E+01	8.1E-01	7.2E+01
Np-237	1.1E+00	3.1E-08	1.4E-02	2.5E-19	1.4E-02	2.5E-19
Pa-231	1.0E+00	5.0E-08	---	---	---	---

--- = *None*

Table 31 (Continued)
Radionuclide Inventories in Waste Disposed of in Shafts, September 27, 1988 through 2003

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pb-210	1.1E+00	2.9E-08	---	---	---	---
Pu-238	1.1E+01	2.2E-02	5.9E-01	1.7E-03	2.4E+01	2.4E-01
Pu-239	1.4E+01	1.6E-02	5.9E-01	1.0E-03	2.4E+01	6.5E-02
Pu-240	1.6E+00	3.7E-03	4.2E-01	2.7E-04	---	---
Pu-241	1.6E+00	8.0E-02	---	---	---	---
Pu-242	4.2E-01	1.6E-07	---	---	---	---
Ra-226	1.4E+00	7.7E-01	5.2E-02	2.0E-09	5.2E-02	2.0E-09
Sm-151	8.2E-01	2.9E-05	---	---	---	---
Sn-121m	8.2E-01	3.0E-03	---	---	---	---
Sn-126	8.2E-01	7.5E-04	---	---	---	---
Sr-90	1.2E+00	7.0E+01	4.2E-01	1.5E-05	---	---
Tc-99	5.4E-04	1.0E-08	---	---	---	---
Th-227	1.0E+00	6.4E-08	---	---	---	---
Th-228	4.9E-01	1.4E-05	2.4E-01	6.3E-06	2.4E-01	6.3E-06
Th-229	3.8E-03	5.4E-08	---	---	---	---
Th-230	5.4E-04	5.3E-09	---	---	---	---
Th-232	3.1E+00	1.8E-01	2.6E-01	1.2E-05	2.6E-01	1.2E-05
U-233	1.9E-02	5.8E-04	---	---	---	---
U-234	8.5E+00	8.0E-01	7.0E-02	5.1E-06	7.0E-02	5.1E-06
U-235	1.5E+01	3.7E-02	8.2E-01	6.7E-07	2.4E+01	1.3E-04
U-236	3.1E-04	3.8E-06	---	---	---	---
U-238	2.2E+01	2.2E+00	9.9E-01	1.8E-05	6.7E-01	1.6E-05

--- = *None*

Table 32
Inventory Projections of Future Waste to be Disposed of in Pits and Shafts

Waste Form by Disposal Unit Type	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pits										
Surface-Contaminated Waste	6.1E+04	2.5E+03	8.2E+01	1.6E-03	7.2E+01	8.2E+00	---	---	6.2E+04	2.5E+03
Soil	5.0E+04	6.0E+01	---	---	---	---	1.4E+04	1.3E-01	6.4E+04	6.0E+01
Concrete and Sludge	6.4E+03	8.3E+01	---	---	---	---	---	---	6.4E+03	8.3E+01
Shafts										
Surface-Contaminated Waste	5.1E+02	2.0E+05	6.8E+02	1.4E+06	---	---	---	---	1.2E+03	1.6E+06
Soil	1.1E+01	1.0E+03	---	---	---	---	---	---	1.1E+01	1.0E+03
Concrete and Sludge	8.8E+00	1.0E+03	---	---	---	---	---	---	8.8E+00	1.0E+03

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Surface-Contaminated Waste										
Ag-108m	1.7E+02	8.1E-04	---	---	---	---	---	---	1.7E+02	8.1E-04
Al-26	4.8E-02	1.3E-03	---	---	---	---	---	---	4.8E-02	1.3E-03
Am-241	2.2E+04	1.3E+01	---	---	---	---	---	---	2.2E+04	1.3E+01
Am-243	7.9E+02	3.9E-02	---	---	---	---	---	---	7.9E+02	3.9E-02
Ba-133	4.0E+02	3.5E-02	---	---	---	---	---	---	4.0E+02	3.5E-02
Be-10	8.2E+01	2.3E-02	---	---	---	---	---	---	8.2E+01	2.3E-02
Bi-207	1.5E+01	3.2E-02	---	---	---	---	---	---	1.5E+01	3.2E-02
Bk-247	6.9E+01	1.2E-06	---	---	---	---	---	---	6.9E+01	1.2E-06
C-14	5.4E+02	1.7E+01	---	---	---	---	---	---	5.4E+02	1.7E+01
Ca-41	8.3E+01	1.4E+00	---	---	---	---	---	---	8.3E+01	1.4E+00
Cf-249	2.7E+01	3.7E-06	---	---	---	---	---	---	2.7E+01	3.7E-06
Cl-36	8.3E+01	9.0E-02	---	---	---	---	---	---	8.3E+01	9.0E-02
Cm-243	4.4E+01	1.6E-04	---	---	---	---	---	---	4.4E+01	1.6E-04
Cm-244	1.5E+00	5.1E-04	---	---	---	---	---	---	1.5E+00	5.1E-04
Co-60	6.6E+03	1.4E+02	---	---	---	---	---	---	6.6E+03	1.4E+02
Cs-135	2.1E+02	5.8E-04	---	---	---	---	---	---	2.1E+02	5.8E-04
Cs-137	1.2E+04	5.8E+00	---	---	---	---	---	---	1.2E+04	5.8E+00
Eu-152	6.8E+02	5.3E-01	---	---	---	---	---	---	6.8E+02	5.3E-01

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Eu-154	6.0E+02	7.3E-02	---	---	---	---	---	---	6.0E+02	7.3E-02
Gd-148	2.9E-01	5.1E-05	---	---	---	---	---	---	2.9E-01	5.1E-05
H-3	3.5E+03	1.6E+03	8.2E+01	1.6E-03	---	---	---	---	3.6E+03	1.6E+03
Ho-163	6.1E+01	4.7E+00	---	---	---	---	---	---	6.1E+01	4.7E+00
Ho-166m	2.6E+01	3.5E-05	---	---	---	---	---	---	2.6E+01	3.5E-05
I-129	2.2E+02	9.2E-05	---	---	---	---	---	---	2.2E+02	9.2E-05
K-40	8.5E+02	3.3E-03	---	---	---	---	---	---	8.5E+02	3.3E-03
Kr-85	1.4E+02	5.9E-02	---	---	---	---	---	---	1.4E+02	5.9E-02
Mo-93	8.7E-01	1.0E-04	---	---	---	---	---	---	8.7E-01	1.0E-04
Nb-91	2.9E-01	2.6E-06	---	---	---	---	---	---	2.9E-01	2.6E-06
Nb-92	2.9E-01	1.5E-05	---	---	---	---	---	---	2.9E-01	1.5E-05
Nb-93m	1.9E+00	1.1E-04	---	---	---	---	---	---	1.9E+00	1.1E-04
Nb-94	2.1E+01	7.7E-02	---	---	---	---	---	---	2.1E+01	7.7E-02
Nd-144	2.9E-01	5.1E-08	---	---	---	---	---	---	2.9E-01	5.1E-08
Ni-59	3.7E+02	6.7E-03	---	---	---	---	---	---	3.7E+02	6.7E-03
Ni-63	5.5E+02	9.4E+00	---	---	---	---	---	---	5.5E+02	9.4E+00
Np-237	1.5E+03	1.3E-02	---	---	---	---	---	---	1.5E+03	1.3E-02
Os-194	2.1E+00	6.7E-07	---	---	---	---	---	---	2.1E+00	6.7E-07
Pa-231	1.4E+01	2.7E-04	---	---	---	---	---	---	1.4E+01	2.7E-04

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pb-210	4.4E+02	9.4E-01	---	---	---	---	---	---	4.4E+02	9.4E-01
Pm-145	6.2E+01	5.6E-01	---	---	---	---	---	---	6.2E+01	5.6E-01
Pu-236	2.9E-01	5.1E-09	---	---	---	---	---	---	2.9E-01	5.1E-09
Pu-238	1.8E+04	2.1E+01	---	---	---	---	---	---	1.8E+04	2.1E+01
Pu-239	2.9E+04	2.4E+01	---	---	---	---	---	---	2.9E+04	2.4E+01
Pu-240	7.0E+03	5.6E-01	---	---	---	---	---	---	7.0E+03	5.6E-01
Pu-241	6.9E+03	1.1E+01	---	---	---	---	---	---	6.9E+03	1.1E+01
Pu-242	6.2E+03	1.0E-02	---	---	---	---	---	---	6.2E+03	1.0E-02
Ra-226	7.6E+02	5.2E-02	---	---	---	---	---	---	7.6E+02	5.2E-02
Ra-228	9.3E+01	2.5E-04	---	---	---	---	---	---	9.3E+01	2.5E-04
Si-32	3.1E+00	6.3E-05	---	---	---	---	---	---	3.1E+00	6.3E-05
Sm-151	1.7E+02	1.8E-07	---	---	---	---	---	---	1.7E+02	1.8E-07
Sn-121m	8.0E+01	1.8E-05	---	---	---	---	---	---	8.0E+01	1.8E-05
Sn-126	8.0E+01	4.5E-06	---	---	---	---	---	---	8.0E+01	4.5E-06
Sr-90	3.2E+03	7.0E-01	---	---	---	---	---	---	3.2E+03	7.0E-01
Tb-157	2.8E+01	2.3E-07	---	---	---	---	---	---	2.8E+01	2.3E-07
Tc-97	5.2E+00	1.1E-05	---	---	---	---	---	---	5.2E+00	1.1E-05
Tc-99	1.0E+03	1.4E+00	---	---	---	---	---	---	1.0E+03	1.4E+00
Th-228	4.6E+02	3.7E-03	---	---	---	---	---	---	4.6E+02	3.7E-03

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Th-229	1.5E+02	1.7E-03	---	---	---	---	---	---	1.5E+02	1.7E-03
Th-230	3.4E+02	1.1E-04	---	---	---	---	---	---	3.4E+02	1.1E-04
Th-232	2.2E+03	3.1E-02	---	---	---	---	---	---	2.2E+03	3.1E-02
Ti-44	2.9E+02	3.6E-03	---	---	---	---	---	---	2.9E+02	3.6E-03
U-232	6.8E+01	3.0E-03	---	---	---	---	---	---	6.8E+01	3.0E-03
U-233	2.0E+02	4.9E-02	---	---	---	---	---	---	2.0E+02	4.9E-02
U-234	5.5E+03	4.6E+00	---	---	7.2E+01	2.4E+00	---	---	5.6E+03	7.0E+00
U-235	1.7E+04	2.7E-01	---	---	7.2E+01	1.1E-01	---	---	1.8E+04	3.8E-01
U-236	1.0E+03	5.7E-04	---	---	---	---	---	---	1.0E+03	5.7E-04
U-238	1.5E+04	1.1E+01	---	---	7.2E+01	5.7E+00	---	---	1.5E+04	1.7E+01
Zr-93	5.8E-01	1.0E-07	---	---	---	---	---	---	5.8E-01	1.0E-07
Soil										
Ac-227	1.5E-01	1.0E-05	---	---	---	---	---	---	1.5E-01	1.0E-05
Am-241	1.8E+04	1.3E+00	---	---	---	---	1.4E+04	6.8E-04	3.2E+04	1.3E+00
Am-243	7.8E+01	2.5E-05	---	---	---	---	---	---	7.8E+01	2.5E-05
C-14	2.1E+01	7.4E-07	---	---	---	---	---	---	2.1E+01	7.4E-07
Cm-243	1.9E+00	5.7E-08	---	---	---	---	---	---	1.9E+00	5.7E-08
Cm-244	5.3E-02	6.3E-10	---	---	---	---	---	---	5.3E-02	6.3E-10
Co-60	1.6E+04	7.5E+00	---	---	---	---	1.4E+04	3.6E-04	3.0E+04	7.5E+00

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Cs-137	1.6E+04	3.8E+00	---	---	---	---	1.4E+04	8.2E-04	3.1E+04	3.8E+00
Eu-152	1.5E+04	1.1E-01	---	---	---	---	---	---	1.5E+04	1.1E-01
Eu-154	6.1E+01	1.4E-02	---	---	---	---	---	---	6.1E+01	1.4E-02
H-3	1.9E+04	1.9E+01	---	---	---	---	---	---	1.9E+04	1.9E+01
K-40	5.8E+02	7.9E-03	---	---	---	---	---	---	5.8E+02	7.9E-03
Kr-85	1.5E-01	1.5E-06	---	---	---	---	---	---	1.5E-01	1.5E-06
Nb-93m	1.9E+00	1.6E-08	---	---	---	---	---	---	1.9E+00	1.6E-08
Nb-94	1.9E+00	1.6E-11	---	---	---	---	---	---	1.9E+00	1.6E-11
Ni-59	1.9E+00	2.0E-05	---	---	---	---	---	---	1.9E+00	2.0E-05
Ni-63	5.5E+01	3.2E-02	---	---	---	---	---	---	5.5E+01	3.2E-02
Np-237	1.7E+01	1.6E-05	---	---	---	---	---	---	1.7E+01	1.6E-05
Pa-231	2.2E+01	5.0E-05	---	---	---	---	---	---	2.2E+01	5.0E-05
Pb-210	1.6E+01	3.7E-02	---	---	---	---	1.4E+04	2.8E-02	1.4E+04	6.5E-02
Pu-238	3.0E+04	1.8E-01	---	---	---	---	1.4E+04	2.4E-03	4.4E+04	1.8E-01
Pu-239	3.4E+04	2.3E+00	---	---	---	---	1.4E+04	3.0E-03	4.9E+04	2.3E+00
Pu-240	3.2E+03	7.9E-01	---	---	---	---	1.4E+04	3.0E-03	1.7E+04	8.0E-01
Pu-241	9.9E-01	1.6E-13	---	---	---	---	---	---	9.9E-01	1.6E-13
Pu-242	3.1E+01	2.4E-05	---	---	---	---	---	---	3.1E+01	2.4E-05
Ra-226	3.5E+02	8.0E-03	---	---	---	---	---	---	3.5E+02	8.0E-03

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ra-228	2.2E+01	1.3E-04	---	---	---	---	1.4E+04	2.4E-02	1.4E+04	2.4E-02
Sm-151	5.2E-01	6.3E-10	---	---	---	---	---	---	5.2E-01	6.3E-10
Sr-90	3.0E+04	8.7E-01	---	---	---	---	1.4E+04	3.6E-02	4.4E+04	9.0E-01
Tc-99	6.0E+01	1.4E-03	---	---	---	---	---	---	6.0E+01	1.4E-03
Th-228	1.8E+02	4.3E-04	---	---	---	---	---	---	1.8E+02	4.3E-04
Th-230	1.5E+02	3.1E-03	---	---	---	---	---	---	1.5E+02	3.1E-03
Th-232	1.2E+03	4.4E-02	---	---	---	---	---	---	1.2E+03	4.4E-02
Ti-44	3.6E+00	2.8E-07	---	---	---	---	---	---	3.6E+00	2.8E-07
U-234	4.0E+03	2.1E-01	---	---	---	---	1.4E+04	1.2E-02	1.8E+04	2.2E-01
U-235	3.6E+03	1.2E-02	---	---	---	---	1.4E+04	2.0E-03	1.8E+04	1.4E-02
U-236	1.5E-01	3.3E-08							1.5E-01	3.3E-08
U-238	5.2E+03	6.2E-01	---	---	---	---	1.4E+04	1.1E-02	1.9E+04	6.3E-01
Concrete and Sludge										
Am-241	2.6E+03	1.6E+01	---	---	---	---	---	---	2.6E+03	1.6E+01
Am-243	4.2E+01	2.7E-07	---	---	---	---	---	---	4.2E+01	2.7E-07
C-14	1.1E+02	3.8E-03	---	---	---	---	---	---	1.1E+02	3.8E-03
Cm-243	6.1E+01	5.3E-05	---	---	---	---	---	---	6.1E+01	5.3E-05
Cm-245	1.1E+02	2.4E-04	---	---	---	---	---	---	1.1E+02	2.4E-04
Co-60	2.4E+02	1.3E-01	---	---	---	---	---	---	2.4E+02	1.3E-01

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Cs-137	3.4E+02	1.9E+00	---	---	---	---	---	---	3.4E+02	1.9E+00
Eu-152	4.3E+01	7.7E-03	---	---	---	---	---	---	4.3E+01	7.7E-03
Eu-154	6.3E+00	1.1E-03	---	---	---	---	---	---	6.3E+00	1.1E-03
H-3	2.7E+02	1.6E+00	---	---	---	---	---	---	2.7E+02	1.6E+00
I-129	9.0E+01	5.0E-05	---	---	---	---	---	---	9.0E+01	5.0E-05
K-40	5.4E+01	1.4E-04	---	---	---	---	---	---	5.4E+01	1.4E-04
Kr-85	1.2E+00	8.2E-04	---	---	---	---	---	---	1.2E+00	8.2E-04
Lu-176	1.1E+00	8.7E-06	---	---	---	---	---	---	1.1E+00	8.7E-06
Nb-93m	1.5E-01	1.2E-09	---	---	---	---	---	---	1.5E-01	1.2E-09
Nb-94	1.5E-01	1.2E-12	---	---	---	---	---	---	1.5E-01	1.2E-12
Ni-59	1.5E-01	1.6E-06	---	---	---	---	---	---	1.5E-01	1.6E-06
Ni-63	1.1E+02	1.3E-02	---	---	---	---	---	---	1.1E+02	1.3E-02
Np-237	7.9E+01	3.1E-05	---	---	---	---	---	---	7.9E+01	3.1E-05
Pb-210	2.3E+00	2.8E-03	---	---	---	---	---	---	2.3E+00	2.8E-03
Pu-238	2.5E+03	2.2E+01	---	---	---	---	---	---	2.5E+03	2.2E+01
Pu-239	2.6E+03	2.4E+01	---	---	---	---	---	---	2.6E+03	2.4E+01
Pu-240	1.5E+02	1.7E-01	---	---	---	---	---	---	1.5E+02	1.7E-01
Pu-241	6.9E+01	4.3E-05	---	---	---	---	---	---	6.9E+01	4.3E-05
Pu-242	1.4E+01	5.6E-06	---	---	---	---	---	---	1.4E+01	5.6E-06

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 33 (Continued)
Radionuclide Inventories for Future Waste to be Disposed of in Pits

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Uranium Chips and Turnings [c]		Soil		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pu-244	3.2E+01	1.8E-05	---	---	---	---	---	---	3.2E+01	1.8E-05
Ra-226	8.7E+00	8.1E-05	---	---	---	---	---	---	8.7E+00	8.1E-05
Ra-228	1.7E+00	1.0E-05	---	---	---	---	---	---	1.7E+00	1.0E-05
Sm-151	1.2E+00	3.2E-09	---	---	---	---	---	---	1.2E+00	3.2E-09
Sn-121m	1.2E+00	3.3E-07	---	---	---	---	---	---	1.2E+00	3.3E-07
Sn-126	1.2E+00	8.1E-08	---	---	---	---	---	---	1.2E+00	8.1E-08
Sr-90	1.6E+02	1.4E-02	---	---	---	---	---	---	1.6E+02	1.4E-02
Tc-99	7.2E+01	6.0E-04	---	---	---	---	---	---	7.2E+01	6.0E-04
Th-228	5.5E+01	3.0E-05	---	---	---	---	---	---	5.5E+01	3.0E-05
Th-230	2.9E+01	2.0E-05	---	---	---	---	---	---	2.9E+01	2.0E-05
Th-232	2.3E+02	3.0E-03	---	---	---	---	---	---	2.3E+02	3.0E-03
Ti-44	2.7E-01	2.1E-08	---	---	---	---	---	---	2.7E-01	2.1E-08
U-234	6.6E+02	1.9E-01	---	---	---	---	---	---	6.6E+02	1.9E-01
U-235	2.2E+03	2.9E-02	---	---	---	---	---	---	2.2E+03	2.9E-02
U-236	1.1E-02	2.4E-09	---	---	---	---	---	---	1.1E-02	2.4E-09
U-238	5.2E+02	4.2E-01	---	---	---	---	---	---	5.2E+02	4.2E-01

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 34
Radionuclide Inventories of Future Waste to be Disposed of in Shafts

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Surface-Contaminated Waste						
Ac-227	2.7E-03	2.7E-06	---	---	2.7E-03	2.7E-06
Ag-108m	7.7E+00	2.3E+01	---	---	7.7E+00	2.3E+01
Am-241	4.0E+01	1.1E-02	---	---	4.0E+01	1.1E-02
Am-243	1.5E-01	5.1E-09	---	---	1.5E-01	5.1E-09
Ba-133	2.9E-03	6.5E-03	---	---	2.9E-03	6.5E-03
Bi-207	5.8E-01	2.6E-04	---	---	5.8E-01	2.6E-04
C-14	8.9E+01	8.2E+01	---	---	8.9E+01	8.2E+01
Cf-252	4.9E-03	1.4E-07	---	---	4.9E-03	1.4E-07
Cl-36	2.7E-03	5.1E-08	---	---	2.7E-03	5.1E-08
Cm-244	9.7E-02	2.0E-08	---	---	9.7E-02	2.0E-08
Co-60	2.9E+02	1.1E+04	---	---	2.9E+02	1.1E+04
Cs-137	6.3E+00	2.6E+00	---	---	6.3E+00	2.6E+00
Eu-152	6.4E+00	3.3E-04	---	---	6.4E+00	3.3E-04
Eu-154	2.7E-03	6.2E-06	---	---	2.7E-03	6.2E-06
Gd-148	2.7E-03	3.9E-08	---	---	2.7E-03	3.9E-08
H-3	2.4E+01	5.1E+04	6.8E+02	1.4E+06	7.0E+02	1.4E+06
Ho-163	9.3E+00	3.6E-01	---	---	9.3E+00	3.6E-01

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 34 (Continued)
Radionuclide Inventories of Future Waste to be Disposed of in Shafts

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
K-40	5.3E+00	2.2E-06	---	---	5.3E+00	2.2E-06
Mo-93	1.3E+02	5.6E-02	---	---	1.3E+02	5.6E-02
Ni-59	8.3E+00	6.4E+00	---	---	8.3E+00	6.4E+00
Ni-63	2.1E+02	5.1E+03	---	---	2.1E+02	5.1E+03
Np-237	5.5E+00	1.6E-07	---	---	5.5E+00	1.6E-07
Pa-231	5.3E+00	2.6E-07	---	---	5.3E+00	2.6E-07
Pb-210	5.3E+00	1.3E-07	---	---	5.3E+00	1.3E-07
Pu-238	1.0E+01	1.0E-01	---	---	1.0E+01	1.0E-01
Pu-239	3.5E+01	1.7E-02	---	---	3.5E+01	1.7E-02
Pu-240	5.9E+00	4.8E-03	---	---	5.9E+00	4.8E-03
Pu-241	5.9E+00	1.9E-01	---	---	5.9E+00	1.9E-01
Pu-242	9.7E-03	5.1E-09	---	---	9.7E-03	5.1E-09
Ra-226	7.0E+00	3.9E+00	---	---	7.0E+00	3.9E+00
Sr-90	1.1E+00	2.9E+02	---	---	1.1E+00	2.9E+02
Tc-99	2.7E-03	5.4E-08	---	---	2.7E-03	5.4E-08
Th-228	2.5E+00	7.3E-05	---	---	2.5E+00	7.3E-05
Th-230	2.7E-03	2.7E-08	---	---	2.7E-03	2.7E-08
Th-232	1.6E+01	9.1E-01	---	---	1.6E+01	9.1E-01
U-233	1.0E-01	3.0E-03	---	---	1.0E-01	3.0E-03

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 34 (Continued)
Radionuclide Inventories of Future Waste to be Disposed of in Shafts

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
U-234	4.2E+01	4.1E+00	---	---	4.2E+01	4.1E+00
U-235	4.3E+01	1.8E-01	---	---	4.3E+01	1.8E-01
U-236	1.6E-03	1.9E-05	---	---	1.6E-03	1.9E-05
U-238	5.8E+01	1.0E+01	---	---	5.8E+01	1.0E+01
Soil						
Am-241	3.0E+00	4.5E-04	---	---	3.0E+00	4.5E-04
Am-243	7.3E-02	1.3E-18	---	---	7.3E-02	1.3E-18
Co-60	5.2E+00	4.3E+02	---	---	5.2E+00	4.3E+02
Cs-137	2.1E+00	3.8E-05	---	---	2.1E+00	3.8E-05
H-3	2.4E+00	5.6E-03	---	---	2.4E+00	5.6E-03
Mo-93	4.2E+00	5.4E-03	---	---	4.2E+00	5.4E-03
Ni-59	4.2E+00	3.2E+00	---	---	4.2E+00	3.2E+00
Ni-63	4.2E+00	3.7E+02	---	---	4.2E+00	3.7E+02
Np-237	7.3E-02	1.3E-18	---	---	7.3E-02	1.3E-18
Pu-238	3.0E+00	8.7E-03	---	---	3.0E+00	8.7E-03
Pu-239	3.0E+00	5.1E-03	---	---	3.0E+00	5.1E-03
Pu-240	2.1E+00	1.4E-03	---	---	2.1E+00	1.4E-03
Ra-226	2.7E-01	1.0E-08	---	---	2.7E-01	1.0E-08
Sr-90	2.1E+00	7.5E-05	---	---	2.1E+00	7.5E-05

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 34 (Continued)
Radionuclide Inventories of Future Waste to be Disposed of in Shafts

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Total Future Waste	
	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)	Volume (m³)	Activity (Ci)
Th-228	1.2E+00	3.2E-05	---	---	1.2E+00	3.2E-05
Th-232	1.3E+00	6.2E-05	---	---	1.3E+00	6.2E-05
U-234	2.7E-01	2.6E-05	---	---	2.7E-01	2.6E-05
U-235	4.1E+00	3.4E-06	---	---	4.1E+00	3.4E-06
U-238	5.0E+00	9.1E-05	---	---	5.0E+00	9.1E-05
Concrete and Sludge						
Am-241	8.7E-01	1.3E-05	---	---	8.7E-01	1.3E-05
Am-243	7.3E-02	1.3E-18	---	---	7.3E-02	1.3E-18
Co-60	5.2E+00	4.3E+02	---	---	5.2E+00	4.3E+02
H-3	2.9E-01	5.6E-03	---	---	2.9E-01	5.6E-03
Mo-93	4.2E+00	5.4E-03	---	---	4.2E+00	5.4E-03
Ni-59	4.2E+00	3.2E+00	---	---	4.2E+00	3.2E+00
Ni-63	4.2E+00	3.7E+02	---	---	4.2E+00	3.7E+02
Np-237	7.3E-02	1.3E-18	---	---	7.3E-02	1.3E-18
Pu-238	8.7E-01	4.9E-03	---	---	8.7E-01	4.9E-03
Pu-239	8.7E-01	3.8E-03	---	---	8.7E-01	3.8E-03
Ra-226	2.7E-01	1.0E-08	---	---	2.7E-01	1.0E-08
Th-228	1.2E+00	3.2E-05	---	---	1.2E+00	3.2E-05
Th-232	1.3E+00	6.2E-05	---	---	1.3E+00	6.2E-05

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 34 (Continued)
Radionuclide Inventories of Future Waste to be Disposed of in Shafts

Radionuclide by Waste Form	Extrapolation-Based Inventory [a]		Tritium Waste [b]		Total Future Waste	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
U-234	2.7E-01	2.6E-05	---	---	2.7E-01	2.6E-05
U-235	1.4E+00	1.5E-06	---	---	1.4E+00	1.5E-06
U-238	2.3E+00	8.0E-05	---	---	2.3E+00	8.0E-05

--- = None

[a] Based on data from Los Alamos National Laboratory low-level waste (LLW) and transuranic (TRU) databases

[b] Estimated from data collected from TA-16 and TA-21 personnel

[c] Estimated based on drums of treated and untreated uranium chips and turnings in storage as of 2004

Table 35
Projected Tritium Waste Inventory Generated by Tritium Science Fabrication Facility Cleanup Activities

Waste Stream	Container Type	No. of Containers	Years of Generation	Tritium Concentration
Low-Activity Waste				
Compactable Waste	2.7-m³ dumpster	4 – 5	2 – 3	2.0E-05 Ci/m³
Noncompactable Waste	2.7-m³ B-25 box	4 – 5	2 – 3	2.0E-05 Ci/m³
High-Activity Waste				
Drum Waste	0.21 and 0.32-m³ drums	20	1	500 Ci/drum
Overpack Waste	1.25-m³ stainless steel containers	4 – 6	1	Typically 5.8E+04 to 6.8E+04 Ci/container; maximum of 9.7E+04 Ci/container

Table 36
Projected Tritium Waste Inventory Generated by Weapons Engineering Test Facility

Waste Stream	Container Type	Amount of Waste	Years of Generation	Tritium Concentration or Activity
High-Activity Waste				
Compactable and Noncompactable Waste	Various	15 m³	ongoing	2.0E+03 Ci
Overpack Waste	1.25-m³ stainless steel containers	1 container	ongoing	2.0E+04 Ci/container in 2004; 5.0E+04 Ci/container in 2005-2008; 2.0E+04 Ci/container thereafter

Table 37
Projected Combined Tritium Waste Inventory from Tritium Science Fabrication and Weapons Engineering Test Facilities

Disposal Unit	Surface-Contaminated Tritium Waste	
	Volume (m³)	Activity (Ci)
Pits	8.2E+01	1.6E-03
Shafts	6.8E+02	1.4E+06

The projected inventory of uranium chips and turnings accounts for the waste that was in storage at the time the inventory characterization update was conducted, waste that may be shipped to the Laboratory for treatment and disposal, and material expected to be generated by ongoing operations. The stored waste includes 55 drums (0.11-m^3 [30-gal] capacity) of treated uranium chips; the radiological characteristics of this waste are summarized in Table 38. At the time of this analysis, an additional 22 drums of waste were in storage awaiting treatment, and approximately 60 more drums of chips and turnings were expected to be sent to MDA G for treatment and disposal by another DOE laboratory. It was assumed that the 82 drums of untreated waste contained depleted uranium with an activity equal to the median activity of the treated drums of waste (0.13 Ci/drum).

Future generation rates of uranium chips and turnings will depend upon programmatic needs at the Laboratory. Historically, 5 to 10 drums (0.11-m^3 [30-gal] capacity) of waste have been generated annually. This generation rate increased to 40 to 50 drums in 2003, a rate that is expected to continue for the next few years. It is not clear if generation rates will continue at this rate after 2005 or if they will return to historical norms. On the basis of this information, however, it was assumed that 45 drums of chips and turnings would be generated annually in 2004 and 2005. Rates of generation were assumed to decrease linearly to an annual generation rate of 7.5 drums of waste by 2007 and to remain at this level until 2044. All drums of waste generated in the future were assumed to have a depleted uranium activity equal to the median D38 activity calculated for the drums of stored treated waste.

The total future inventory of uranium chips and turnings is summarized in Table 39. The listed activities of depleted uranium were allocated to specific isotopes of uranium using the material type definitions provided in Table 4, yielding 2.4 Ci of U-234, 0.1 Ci of U-235, and 5.7 Ci of U-238. All chips and turnings were assumed to be disposed of in pits; the waste was assigned to the surface-contaminated waste form. The uranium chips and turnings are included in the radionuclide-specific inventories listed in Tables 32 and 33.

Approximately 1.3×10^4 m^3 (4.6×10^5 ft^3) of soil had been excavated at TA-50 and disposed of at MDA G as the inventory characterization effort was being completed; an additional 1.3×10^4 m^3 (4.6×10^4 ft^3) of waste were expected to be disposed of as the excavation was completed. The radiological characteristics of the soil were estimated on the basis of information taken from the LLW disposal database. The radionuclide contents in the material that had not yet been shipped to MDA G were estimated using the average radionuclide concentrations in the soil that had undergone disposal. The total radionuclide inventories in the soil are summarized in Table 40 for those isotopes that were not eliminated on the basis of half-life. All of this waste has been, or will be, placed in disposal pits.

Table 38
Radiological Characteristics of Treated Uranium Chips and Turnings in Storage

Container Number	Radionuclide Code	Depleted Uranium Activity (Ci)
L02148626	D38	2.1E-02
L02148627	D38	3.5E-02
L02148628	D38	3.8E-02
L02148625	D38	2.2E-02
L02148629	D38	8.1E-03
L02148630	D38	1.4E-02
L02148631	D38	1.7E-02
L02152297	D38	9.5E-03
L02152298	D38	1.3E-02
L02152299	D38	9.0E-03
L02152300	D38	1.2E-02
L02152301	D38	2.1E-02
L02152302	D38	1.0E-02
L02152303	D38	7.0E-03
L02152304	D38	8.5E-03
L02152305	D38	1.0E-02
L02152306	D38	9.0E-03
L02152307	D38	1.2E-02
L02152308	D38	1.2E-02
L02152309	D38	1.4E-02
L02152310	D38	1.1E-02
L02152311	D38	1.5E-02
L02152312	D38	3.0E-02
L02152313	D38	8.5E-03
L02152314	D38	8.5E-03
L02152315	D38	1.1E-02
L02152316	D38	1.2E-02
L02152317	D38	8.5E-03
L02152318	D38	7.5E-03
L02152319	D38	1.5E-02
L02154095	D38	1.8E-02

Table 38 (Continued)
Radiological Characteristics of the Treated Uranium Chips and Turnings in Storage

Container Number	Radionuclide Code	Depleted Uranium Activity (Ci)
L02154096	D38	9.0E-03
L02154097	D38	8.5E-03
L02154098	D38	1.6E-02
L02154099	D38	1.7E-02
L03160485	D38	8.0E-03
L03160486	D38	1.4E-02
L03160487	D38	6.5E-03
L03160488	D38	1.3E-02
L03160489	D38	1.8E-02
L03160490	D38	1.7E-02
L03160491	D38	1.6E-02
L03160492	D38	1.3E-02
L03160493	D38	1.5E-02
L03160494	D38	8.5E-03
L03160495	D38	1.9E-02
L03160496	D38	8.0E-03
L03160497	D38	6.5E-03
L03160925	D38	4.1E-02
L03160926	D38	4.0E-02
L03160927	D38	4.1E-02
L03160928	D38	4.1E-02
L03160929	D38	4.1E-02
L03160930	D38	3.0E-02
C92028866	U238	2.8E-02

Table 39
Projected Inventory of Uranium Chips and Turnings

Radionuclide by Type of Waste	Volume (m^3)		Activity (Ci)
Stored Treated Waste			
D-38	6.2E+00		8.9E-01
U-238	1.1E-01		2.8E-02
Stored Untreated Waste			
D-38	2.5E+00		2.8E-01
Off-Site Waste			
D-38	6.8E+00		7.5E-01
Operational Waste			
D-38	5.7E+01		6.2E+00

Table 40
Radionuclide Inventories in Excavated Soil from TA-50

Radionuclide	Volume (m^3)	Activity (Ci)
Am-241	1.4E+04	6.8E-04
Co-60	1.4E+04	3.6E-04
Cs-137	1.4E+04	8.2E-04
Pb-210	1.4E+04	2.8E-02
Pu-238	1.4E+04	2.4E-03
Pu-239	1.4E+04	3.0E-03
Pu-240	1.4E+04	3.0E-03
Ra-228	1.4E+04	2.4E-02
Sr-90	1.4E+04	3.6E-02
U-234	1.4E+04	1.2E-02
U-235	1.4E+04	2.0E-03
U-238	1.4E+04	1.1E-02

4.3 *Uncertainty Analysis*

The inventories presented in this report are estimates of the quantities of the radioactive materials that were, or will be, disposed of in the pits and shafts at MDA G. These projections are subject to uncertainty introduced by the assumptions made in developing the inventories and the data upon which the estimates are based. Potentially important sources of uncertainty associated with the inventory projections are discussed below.

The primary sources of uncertainty associated with the MDA G inventory projections depend, in part, upon the segment of the inventory under consideration. Perhaps the most basic source of uncertainty, and one that applies to all of the waste disposed of at MDA G, is the measurement or estimation of radionuclide activities in the waste. The accuracy of the activity measurements and estimation techniques used to characterize MDA G waste is influenced by the radionuclides under consideration and the time at which disposal occurred. Specific radionuclides may affect characterization efforts in two distinct ways. First, the radiation types and energies emitted by the isotopes may make measurement more or less difficult. For example, high-energy gamma emissions from a radionuclide such as Co-60 are generally more readily detected than low-energy beta emissions from tritium. Second, accountability requirements for some radionuclides are such that greater effort has been invested in measuring or estimating activities associated with the waste packages.

Timing of waste disposal is also an important factor affecting the accuracy of the activity estimates. In general, detection equipment has improved over the years, as have efforts to more accurately characterize the material placed in the disposal facility. MDA G has been in operation for over 40 years, during which time changes in technology and focus have significantly impacted the accuracy of the inventory estimates.

The measurement errors associated with the activities listed in the LLW and TRU waste databases cannot be determined with a high degree of accuracy, but some generalities can be drawn about this source of uncertainty. The information summarized below is based on discussions with LANL personnel experienced in radiation characterization procedures and measurement techniques (Myers, 2004).

The radionuclides included in the MDA G inventory have been divided into a number of classes or groups to simplify this discussion about uncertainty. These classes include pure beta emitters such as C-14, Ni-63, Sr-90 and Tc-99; gamma emitters such as Co-60 and Cs-137; alpha emitters such as americium, plutonium, and uranium; and tritium. The greatest uncertainties are expected to be associated with the measurement of the activities of the pure beta emitters. The low energy and penetrating power of beta radiation are such that detailed separation techniques must be performed before accurate assessments of the waste activity can be conducted. Characterization efforts at the Laboratory rarely, if ever, include these analyses for this class of waste. As a result, the activities associated with these radionuclides are expected to be accurate only to within one order of magnitude.

In theory, the higher energy emissions associated with many gamma emitters should make accurate characterization an easier task. Nevertheless, gamma waste disposed of prior to the 1990s is expected to have a similar level of accuracy as that discussed for the beta emitters. The magnitude of the errors associated with the gamma emitters decreased during the 1990s to the extent that errors are currently on the order of ±25 percent to ±100 percent, depending upon the size and composition of the waste package.

Greater effort has generally been expended on the characterization of waste contaminated with uranium and transuranics because of accountability issues. However, the concentrations of americium, plutonium, and uranium in the waste have a significant impact on the accuracy of the measured activities. Activities of these radionuclides have probably been overestimated in LLW because concentrations in this waste are low and the former measurement techniques used did not have very low detection limits. Drums and boxes with detectable quantities of plutonium (i.e., on the order of 0.50 g [0.001 lb] or more per package) are likely to have errors on the order of 20 to 30 percent for measurements conducted in the 1970s and 1980s; errors on the order of 10 to 20 percent are typical for more recent measurements.

The errors estimated for the uranium and transuranic waste may not always be realized. For example, some waste generators measured drums of TRU waste using neutron counters and used scaling factors to estimate isotopic distributions. Inappropriately applied scaling factors have resulted in overestimates of some isotopes' activities and underestimates of others. For example, Am-241 activities have been underestimated by an order of magnitude or more in a small proportion of TRU waste drums because of the misapplication of scaling factors.

The ability to accurately measure the quantities of uranium isotopes depends, in part, on the isotopic quantities in the waste package. For example, U-235 has gone undetected during the assay of drums of TRU waste that contain a few grams or less of the isotope; errors of this sort may occur in a small proportion of the drums. Generators are usually aware of drums that contain greater quantities of U-235 (e.g., 10 g [0.022 lb] or more) and measure the packages directly to determine the waste activity. Waste containing depleted uranium is usually measured with errors of ±25 percent to ±100 percent, depending upon the size and composition of the package.

Although tritium is a pure beta emitter, it is considered separately from the other beta emitters because of its generation pattern at the Laboratory. Low-activity tritium waste is expected to have uncertainties associated with its characterization similar to those discussed for the pure beta emitters. However, high-activity tritium waste receives greater scrutiny. Measurement errors associated with high-activity tritium waste disposed of prior to the 1990s are expected to be on the order of ±100 percent. Improvements since that time have reduced these errors to values that are expected to be on the order of ±25 percent.

An extrapolation process was used to estimate the quantities of waste disposed of in pits prior to 1971 and in pits and shafts from 2004–2044. The pre-1971 pit inventory was estimated, in part, on the basis of waste disposed of from 1971–1977; the 2004–2044 pit and shaft inventories were based on the characteristics of the material disposed of from 1996–2003. In each case, it was implicitly assumed that the waste disposed of during the extrapolation period was similar to that emplaced during the period of interest.

It is unlikely that the nature of the waste that was disposed of in pits during the early to mid-1970s extrapolation period was exactly the same as material emplaced from 1959–1970. Some insight into the error introduced by using the extrapolation approach as a means for estimating the inventory for this waste may be gained by examining the results of the pre-1971 disposal record review (Pollard and Shuman, 1999); this evaluation is described in Sections 3.1 and 4.1.1.

In general, the americium and plutonium activities included in the 1997 composite analysis inventory for the concrete and sludge disposed of in pits prior to 1971 agreed with available historical disposal data (Table 14). However, the majority of the Am-241 and Pu-239 activities included in the 1997 composite analysis and in the inventory update are based on data published by Warren (1980); the extrapolation process had little to do with these projections. The Pu-238 sludge inventory estimated in 1997 and updated in this study was based on the extrapolation process and generally agrees with the inventory estimated using the historical sludge disposal data.

Radionuclide inventories estimated for the pre-1971 nonsludge waste streams on the basis of the extrapolation approach do not compare favorably with estimates developed using historical data records. For all radionuclides examined, the total activity estimates developed for the 1997 composite analysis readily exceed the activities indicated by the disposal data. As discussed earlier, it is unclear if this finding signifies that the extrapolation process is inappropriate or if the historical data are incomplete in terms of this waste.

Dissimilarities between the future waste (to be emplaced from 2004–2044) and the 1996–2003 extrapolation data used to estimate future pit and shaft inventories may also be expected. The imposition of a 2,850 m^3 (10×10^5 ft^3) annual disposal limit on future waste disposal operations at MDA G introduces additional uncertainty into the future inventory projections for several reasons. First, it is not clear if the annual disposal limit will be maintained over the remainder of the disposal facility's lifetime; if not, the inventory projections may underestimate the actual quantities of waste that will be placed in the pits and shafts. Second, changes in LANL operations may result in shifts in the relative proportions of the operational and ER and D&D waste that is disposed of at MDA G. Given that the radiological characteristics of the two types of waste differ, any such shifts will affect the estimated inventories. Finally, if the disposal limit is enforced, a portion of the ER and D&D waste is expected to be disposed of at an off-site location. It is not clear what quantities and types of waste will be retained on site under these conditions; if the radiological properties of the waste placed at MDA G differ from those assumed in the inventory update then the future inventory projections may be compromised.

Many of the waste packages disposed of at MDA G contained activation- and fission-product waste; in many instances the radionuclides in these packages were simply listed in terms of total activities of MAP and MFP. As discussed earlier, these activities were allocated to specific radionuclides using the methods described in *Attachment III*. Several sources of uncertainty are associated with the allocation of the MFP activities to specific radionuclides:

- Nature of the fission reactions that generate the fission products
- Age of the MFP waste
- Impacts of daughter ingrowth

These sources of uncertainty are discussed below.

The identity of the fissile materials that led to the generation of the MFP appears to be clear. Pu-239 and U-235 are common fissile materials and are associated with a large number of the waste packages that contain the MFP. What is not clear from the waste data is what proportion of the waste was generated by Pu-239 fission as opposed to reactions involving U-235, and what proportion of the waste was the result of interactions with thermal and fast neutrons.

Fission yields and, hence, the radionuclides assigned to the MFP waste, will vary depending upon the fissile material and the neutron energy. This is illustrated by the fission yields that are listed in Table III-2 (see *Attachment III*). The effect that these differences in yield may have on the radionuclide allocations is more apparent through an examination of Table III-3, which shows that the minimum and maximum activity fractions for a given radionuclide may differ by a factor of two or more, and commonly by more than an order of magnitude.

The short-lived nature of the majority of the fission products requires that an accurate assessment be made of the age of the waste at the time of disposal. The composition of the waste changes rapidly as radionuclides with very short half-lives decay. The effects of decay on waste composition are apparent from a comparison of the number of radionuclides included in the waste at the time the material is generated (Table III-2) and the number of radionuclides present when the waste is 1 or more years old (Table III-3).

The error introduced into the inventory projections by uncertainties in the age of the MFP waste may be significant. For example, the activity allocation fractions for Cs-137, averaged over the thermal and fast neutron yields for Pu-239 and U-235, increase from about 0.14 Ci to 0.73 Ci as the age of the MFP waste increases from 1 to 10 years. Thus, changing the waste age by an order of magnitude results in a five-fold change in the projected inventory.

Most radionuclides associated with MFP waste are very short-lived and decay to negligible levels within a matter of days or weeks. The daughter products generated by the decay process may, in some instances, be longer-lived than their parents and, as a result, contribute to estimated MFP waste activities beyond the time of generation. Due to the very large number of short-lived daughter products, however, the contributions of long-lived daughter products were not taken into account in the current inventory update. This simplification will underestimate the activities of any long-lived daughters that were overlooked and overestimate the activities of the radionuclides that were carried forward in the analysis.

The allocation of the listed MAP activities to specific radionuclides was based on information provided by the Los Alamos Neutron Science Center (formerly the Los Alamos Meson Physics Facility) at TA-53, a major generator of MAP waste. This facility generates three major waste streams of activated waste including trash, beam-line inserts, and targets; the activity allocation factors adopted for the inventory update are based on a characterization of the trash. While similar activated materials may occur in all three waste streams, it is unclear if the allocation factors developed for the trash accurately represent the targets and beam-line inserts.

Many of the radionuclides in the MAP waste are short-lived and will undergo significant decay between the time of generation and disposal. Similar to the situation noted for the MFP waste, the decay dynamics of the waste will have a significant impact on the fractional abundances of the radionuclides in the material. Both the age of the waste at the time the allocation factors were developed and the age of the waste at the time it was disposed of at MDA G are unknown. Lacking this information, it was assumed these two ages were the same. If this is not the case, the relative activities of the radionuclides in the waste will be different.

A number of material types have been used to refer to specific radionuclide compositions; the majority of these have been used to identify isotopic mixtures of uranium and plutonium isotopes. The MDA G pit and shaft inventory update includes approximately 1.1×10^4 Ci of activity reported using these material types; this activity was allocated to specific radionuclides using the factors provided in Table 4. More than 99 percent of the material type activity included in the inventory is represented by plutonium material types PU52, PU53, PU54, PU56, and PU83.

Although the factors used to allocate the material type activities are given as point estimates (see Table 4), waste with a range of radionuclide contents may be assigned to a specific material type. Consequently, using these point estimates to assign material type activities to specific radionuclides will introduce uncertainty into the inventory projections for the affected waste. The errors introduced by these uncertainties are examined below for the plutonium material types that dominated this category of waste.

Waste was assigned to a material type on the basis of the mass content of specific radionuclides in the waste. Table 41 shows the criteria used to assign waste to the plutonium material types of interest. For four of these material types the radionuclide upon which assignment of the waste is based is Pu-240; PU83 is the material type for waste that is essentially all Pu-238.

Table 41
Criteria for Assigning Waste to Selected Plutonium Material Types

Plutonium Material Type	Type Description [a]
PU52	4.0 to < 7.0 % Pu-240
PU53	7.0 to < 10.0 % Pu-240
PU54	10.0 to < 13.0 % Pu-240
PU56	16.0 to < 20.0 % Pu-240
PU83	Total Pu-238

[a] *Fractional amounts are mass-based*

The process used to define the material types used at the Laboratory has been documented by Taggart (1992). Taggart's memorandum includes several estimates of the composition of the plutonium material types listed in Table 41. The means and ranges of the estimates listed by Taggart were calculated and compared to the factors listed in Table 4 to gain insight into the potential variability of the material type definitions. These statistics were defined on an activity basis so they could be compared to the factors listed in Table 4. The results of this evaluation are summarized in Table 42. An examination of these results reveals that the minimum and maximum allocation factors generally fall within 50 percent of the mean values. Similarly, the minimum and maximum factors listed in Table 42 typically differ from the allocation factors listed in Table 4 by a factor of two or less.

As discussed earlier, definitions were unavailable for several material types including GAMMA, GRALPH, GRBETA, PU41, U71, and TRU. Lacking these definitions, waste assigned to these material types was excluded from the inventory characterization. This is not expected to introduce significant error into the final inventory projections because the total activity associated with all of these material types is approximately 1.5 Ci.

Table 42
Activity Allocation Factors for Plutonium Waste Material Types

Material Type	Activity Allocation Factor									
	Pu-238		Pu-239		Pu-240		Pu-241		Pu-242	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
PU52	6.9E-03	3.8E-03 – 1.1E-02	1.2E-01	9.3E-02 – 1.5E-01	2.9E-02	2.1E-02 – 3.5E-02	8.4E-01	8.0E-01 – 8.8E-01	2.0E-06	0.0E+00 – 3.6E-06
PU53	9.1E-03	5.9E-03 – 1.1E-02	8.8E-02	6.5E-02 – 1.1E-01	3.0E-02	2.2E-02 – 4.1E-02	8.7E-01	8.3E-01 – 9.1E-01	4.0E-06	0.0E+00 – 8.1E-06
PU54	8.2E-03	4.8E-03 – 1.2E-02	6.0E-02	3.0E-02 – 1.1E-01	3.0E-02	1.5E-02 – 5.5E-02	9.0E-01	8.3E-01 – 9.5E-01	3.7E-06	0.0E+00 – 6.4E-06
PU56	8.0E-03	7.0E-03 – 8.9E-03	2.7E-02	1.9E-02 – 3.5E-02	1.9E-02	1.4E-02 – 2.5E-02	9.5E-01	9.3E-01 – 9.6E-01	1.0E-05	9.2E-06 – 1.1E-05
PU83	9.7E-01	9.6E-01 – 9.9E-01	7.1E-04	5.8E-04 – 8.4E-04	3.2E-04	2.0E-04 – 4.8E-04	2.4E-02	4.5E-03 – 4.3E-02	1.9E-07	0.0E+00 – 2.9E-07

A large quantity of soil excavated in conjunction with the construction of the Pump House and Influent Storage Tanks Facility at TA-50 was being disposed of at MDA G as this report was being completed. The LLW disposal data that were used to characterize this material are based on sampling data reported by Newell et al. (2002), who collected a series of soil and tuff samples at depths of up to 27 m (90 ft). A summary of the radionuclide concentrations found in samples collected from depths of 7.6 m (25 ft) or less is provided in Table 43; this range of depths generally corresponds with the depth of excavation. The radionuclides included in the table are those that were not eliminated from the inventory characterization on the basis of half-life. Duplicate samples collected for some sampling depths are not reflected in Table 43.

Table 43
Summary Statistics for TA-50 Soil-Sampling Investigation

Radionuclide	N	Concentration (pCi/g)		
		Mean	Median	Range
Am-241	5	4.2E-02	3.0E-02	9.0E-03 – 1.0E-01
Co-60	1	2.0E-02	2.0E-02	NA
Cs-137	10	4.7E-02	3.0E-02	6.0E-03 – 2.1E-01
Pb-210	22	1.6E+00	1.5E+00	1.2E+00 – 3.6E+00
Pu-238	9	1.4E-01	5.0E-02	1.0E-02 – 8.0E-01
Pu-239/240	14	1.7E-01	1.0E-01	2.0E-02 – 4.7E-01
Ra-228	24	1.3E+00	1.2E+00	1.1E+00 – 5.2E+00
Sr-90	7	2.0E+00	2.2E+00	1.4E+00 – 2.6E+00
U-234	22	3.7E+00	6.2E-01	3.8E-01 – 6.7E+01
U-235	10	1.1E-01	1.1E-01	4.0E-02 – 1.5E-01
U-238	22	6.2E-01	5.8E-01	3.8E-01 – 1.0E+00

Source: Newell et al., 2002

NA = Not applicable; range could not be specified because only one sample was analyzed

The radionuclide concentrations in the TA-50 soils generally range over two orders of magnitude or less. Using a bulk density of 1,400 kg/m^3 for the waste, the concentrations used to estimate the radionuclide inventories in this waste are in close agreement with the mean and median values reported in Table 43. Consequently, the minimum and maximum soil concentrations listed in Table 43 generally fall within an order of magnitude of the values upon which the inventory estimates are based, and are usually within a factor of five of these values.

4.4 Summary of the MDA G Radioactive Waste Inventory

The MDA G performance assessment addresses the LLW disposed of since September 26, 1988 and the waste expected to require disposal over the remainder of the facility's lifetime (through 2044). The characteristics of this waste are detailed in Sections 4.1.3 and 4.2 of this report. The summary tables discussed below are based on the information provided in those sections.

The total volumes and activities of waste projected to be disposed of in MDA G pits and shafts from September 27, 1988 through 2044 are listed in Table 44. Separate inventories are provided for surface-contaminated waste, soil, and concrete and sludge and are summed over all pits and shafts that have or will receive waste during this period. The projected radionuclide-specific inventories for this waste are provided in Tables 45 and 46 for the pits and shafts, respectively. The waste volumes listed in these tables represent the quantities of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of these volumes is greater than the total volume of waste that is projected to be disposed of in the pits and shafts. All activities listed in Tables 44–46 are as-disposed activities.

Table 44
Volumes and Activities for Waste Included in the MDA G Performance Assessment Inventory [a]

Waste Form by Type of Disposal Unit	Volume (m^3)	Activity (Ci)
Pits		
Surface-Contaminated Waste	1.0E+05	3.5E+03
Soil	8.1E+04	8.3E+01
Concrete and Sludge	9.2E+03	1.1E+02
Shafts		
Surface-Contaminated Waste	1.6E+03	3.0E+06
Soil	2.1E+01	1.2E+03
Concrete and Sludge	3.5E+01	1.2E+03

[a] *Includes waste disposed of from September 27, 1988 through the end of 2044*

The inventory developed for the composite analysis includes all waste that has been disposed of at MDA G since the facility opened in 1957 and the waste expected to require disposal over the remainder of the facility's lifetime. Estimated quantities, physical forms, and radiological characteristics of this waste are presented and discussed in Sections 4.1 and 4.2 of this report. The summary tables discussed below are based on the information provided in those sections.

Table 45
Pit Radionuclide Inventories for Waste Included in the MDA G Performance Assessment [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ac-227	---	---	2.0E-01	1.4E-05	---	---
Ag-108m	2.0E+02	9.7E-04	---	---	---	---
Al-26	8.6E-02	1.6E-03	---	---	---	---
Am-241	2.9E+04	1.5E+01	3.9E+04	1.8E+00	3.3E+03	2.0E+01
Am-243	1.0E+03	4.7E-02	1.1E+02	9.1E-05	6.1E+01	5.9E-05
Ba-133	4.8E+02	4.3E-02	---	---	---	---
Be-10	9.8E+01	2.8E-02	---	---	---	---
Bi-207	1.9E+01	3.9E-02	---	---	---	---
Bk-247	1.0E+02	1.4E-06	---	---	---	---
C-14	7.1E+02	2.0E+01	3.7E+01	4.0E-05	1.4E+02	4.6E-03
Ca-41	9.9E+01	1.7E+00	---	---	---	---
Cf-249	3.2E+01	4.4E-06	---	---	---	---
Cf-252	1.4E-01	1.4E-05	---	---	---	---
Cl-36	9.9E+01	1.1E-01	---	---	---	---
Cm-243	5.3E+01	1.9E-04	2.6E+00	7.7E-08	7.3E+01	6.3E-05
Cm-244	1.7E+00	6.1E-04	7.2E-02	8.5E-10	---	---
Cm-245	---	---	---	---	1.4E+02	2.8E-04
Co-60	1.2E+04	1.8E+02	3.6E+04	1.0E+01	6.3E+02	9.1E-01
Cs-135	2.5E+02	7.1E-04	---	---	---	---
Cs-137	1.7E+04	1.1E+01	3.7E+04	5.7E+00	9.6E+02	2.7E+00
Eu-152	9.2E+02	8.1E-01	2.0E+04	1.5E-01	7.1E+01	4.3E-02
Eu-154	2.1E+03	1.1E-01	3.1E+02	1.9E-02	5.8E+01	6.1E-03
Gd-148	3.5E-01	6.1E-05	---	---	---	---
H-3	5.2E+03	2.2E+03	2.6E+04	2.8E+01	4.2E+02	2.6E+00
Ho-163	8.6E+01	5.6E+00	---	---	---	---
Ho-166m	3.1E+01	4.1E-05	---	---	---	---

-- = None

[a] Includes waste disposed of from September 27, 1988 through the end of 2044

Table 45 (Continued)
Pit Radionuclide Inventories for Waste Included in the MDA G Performance Assessment [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
I-129	2.6E+02	1.1E-04	---	---	1.1E+02	6.0E-05
K-40	1.1E+03	4.8E-03	7.8E+02	1.1E-02	1.0E+02	5.6E-04
Kr-85	1.4E+03	2.3E-00	2.3E+02	2.1E-04	3.3E+01	1.1E-03
Lu-176	---	---	---	---	1.3E+00	1.0E-05
Mo-93	1.0E+00	1.2E-04	---	---	---	---
Nb-91	3.5E-01	3.1E-06	---	---	---	---
Nb-92	3.5E-01	1.8E-05	---	---	---	---
Nb-93m	3.6E+00	1.3E-04	2.6E+00	2.1E-08	8.4E-01	6.9E-09
Nb-94	2.7E+01	1.2E-01	3.3E+00	3.0E-08	1.5E+00	3.0E-08
Nd-144	3.5E-01	6.1E-08	---	---	---	---
Ni-59	4.6E+02	1.3E-02	3.0E+00	4.2E-05	1.2E+00	2.3E-05
Ni-63	7.5E+02	1.1E+01	7.5E+01	4.3E-02	1.5E+02	2.6E-02
Np-237	1.8E+03	1.6E-02	2.4E+01	2.1E-05	9.7E+01	3.8E-05
Np-239	1.2E+02	2.1E-05	3.4E-01	5.6E-07	3.4E-01	5.6E-07
Os-194	2.5E+00	8.0E-07	---	---	---	---
Pa-231	2.0E+01	3.3E-04	3.0E+01	6.8E-05	---	---
Pb-210	5.4E+02	1.2E+00	1.4E+04	7.8E-02	8.2E+00	1.6E-02
Pm-145	9.1E+01	6.7E-01	---	---	---	---
Pu-236	3.5E-01	6.1E-09	---	---	---	---
Pu-238	2.4E+04	2.5E+01	4.1E+04	1.9E+00	3.2E+03	2.9E+01
Pu-239	4.0E+04	3.2E+01	6.2E+04	3.4E+00	3.8E+03	3.0E+01
Pu-240	1.0E+04	9.5E-01	1.8E+04	1.1E+00	2.1E+02	2.0E-01
Pu-241	1.0E+04	1.8E+01	2.3E+00	1.6E-07	8.4E+01	5.1E-05
Pu-242	9.0E+03	1.3E-02	4.4E+01	9.0E-05	1.8E+01	6.3E-05
Pu-244	---	---	---	---	3.8E+01	2.1E-05
Ra-226	9.9E+02	8.6E-02	4.8E+02	1.1E-02	4.5E+01	4.6E-04
Ra-228	1.3E+02	3.9E-04	3.0E+01	1.8E-04	9.7E+00	5.6E-05

-- = None

[a] Includes waste disposed of from September 27, 1988 through the end of 2044

Table 45 (Continued)
Pit Radionuclide Inventories for Waste Included in the MDA G Performance Assessment [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Si-32	3.8E+00	7.5E-05	---	---	---	---
Sm-151	1.5E+03	8.7E-05	2.3E+02	1.6E-09	3.3E+01	4.4E-09
Sn-121m	1.4E+03	9.0E-04	2.3E+02	8.2E-08	3.3E+01	4.3E-07
Sn-126	1.4E+03	2.2E-04	2.3E+02	2.0E-08	3.3E+01	1.0E-07
Sr-90	5.8E+03	3.7E+00	5.5E+04	1.2E+00	5.1E+02	5.4E-02
Ta-182	5.9E+02	7.7E+00	---	---	---	---
Tb-157	3.4E+01	2.7E-07	---	---	---	---
Tc-97	6.6E+00	1.3E-05	---	---	---	---
Tc-99	1.5E+03	1.7E+00	9.4E+01	1.9E-03	1.1E+02	1.2E-03
Th-228	5.9E+02	5.6E-03	2.4E+02	5.9E-04	7.0E+01	5.9E-05
Th-229	1.9E+02	2.1E-03	1.7E-01	5.2E-07	1.7E-01	5.2E-07
Th-230	4.2E+02	1.3E-04	2.0E+02	4.2E-03	3.4E+01	2.4E-05
Th-232	3.2E+03	9.1E-02	1.6E+03	6.0E-02	5.6E+02	1.1E-02
Ti-44	3.5E+02	4.3E-03	4.8E+00	3.8E-07	1.5E+00	1.2E-07
U-232	8.2E+01	3.7E-03	1.0E-01	5.7E-05	1.0E-01	5.7E-05
U-233	2.5E+02	6.0E-02	4.0E+00	3.4E-04	4.0E+00	3.4E-04
U-234	8.6E+03	8.5E+00	2.0E+04	3.2E-01	1.1E+03	2.4E-01
U-235	2.4E+04	1.1E+00	2.0E+04	7.5E-02	3.2E+03	9.2E-02
U-236	1.3E+03	1.0E-03	6.1E+00	6.0E-05	6.0E+00	6.0E-05
U-238	2.0E+04	2.9E+01	2.2E+04	1.0E+00	1.0E+03	5.4E-01
Zr-93	6.94E-01	1.2E-07	---	---	---	---

-- = None

[a] *Includes waste disposed of from September 27, 1988 through the end of 2044*

Table 46
Shaft Radionuclide Inventories for Waste Included in the MDA G Performance Assessment [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ac-227	3.3E-03	3.2E-06	---	---	---	---
Ag-108m	9.2E+00	2.7E+01	---	---	---	---
Am-241	5.5E+01	1.5E-02	3.6E+00	5.4E-04	2.5E+01	6.9E-02
Am-243	1.9E-01	6.1E-09	8.7E-02	1.5E-18	8.7E-02	1.5E-18
Ba-133	3.4E-02	8.1E-03	---	---	---	---
Bi-207	7.0E-01	3.1E-04	---	---	---	---
C-14	1.1E+02	9.8E+01	---	---	---	---
Cf-252	9.6E-03	2.1E-07	---	---	---	---
Cl-36	3.3E-03	6.1E-08	---	---	---	---
Cm-244	1.2E-01	2.4E-08	---	---	---	---
Co-60	4.4E+02	1.4E+04	6.3E+00	5.2E+02	6.3E+00	5.2E+02
Cs-135	2.7E+00	4.5E-06	---	---	---	---
Cs-137	1.3E+01	9.3E+01	2.6E+00	4.5E-05	---	---
Eu-152	7.8E+00	2.6E-03	---	---	---	---
Eu-154	1.2E+00	9.7E-02	---	---	---	---
Gd-148	3.3E-03	4.7E-08	---	---	---	---
H-3	7.9E+02	2.8E+06	2.9E+00	6.7E-03	3.5E-01	6.7E-03
Ho-163	1.1E+01	4.3E-01	---	---	---	---
K-40	6.4E+00	2.6E-06	---	---	---	---
Kr-85	8.2E-01	7.5E+00	---	---	---	---
Mo-93	1.5E+02	6.7E-02	5.0E+00	6.5E-03	5.0E+00	6.5E-03
Nb-92	1.1E-01	4.0E-03	---	---	---	---
Ni-59	1.0E+01	7.7E+00	5.0E+00	3.8E+00	5.0E+00	3.8E+00
Ni-63	2.5E+02	6.1E+03	5.0E+00	4.4E+02	5.0E+00	4.4E+02
Np-237	6.6E+00	1.9E-07	8.7E-02	1.5E-18	8.7E-02	1.5E-18

-- = None

[a] Includes waste disposed of from September 27, 1988 through the end of 2044

Table 46 (Continued)
Shaft Radionuclide Inventories for Waste Included in the MDA G Performance Assessment [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pa-231	6.4E+00	3.1E-07	---	---	---	---
Pb-210	6.4E+00	1.6E-07	---	---	---	---
Pu-238	2.2E+01	1.3E-01	3.6E+00	1.0E-02	2.5E+01	2.4E-01
Pu-239	4.9E+01	3.4E-02	3.6E+00	6.1E-03	2.5E+01	6.9E-02
Pu-240	7.4E+00	8.5E-03	2.6E+00	1.6E-03	---	---
Pu-241	7.4E+00	2.7E-01	---	---	---	---
Pu-242	4.3E-01	1.7E-07	---	---	---	---
Ra-226	8.4E+00	4.7E+00	3.2E-01	1.3E-08	3.2E-01	1.3E-08
Sm-151	8.2E-01	2.9E-05	---	---	---	---
Sn-121m	8.2E-01	3.0E-03	---	---	---	---
Sn-126	8.2E-01	7.5E-04	---	---	---	---
Sr-90	2.3E+00	3.6E+02	2.6E+00	9.0E-05	---	---
Ta-182	1.6E+01	9.0E+02	---	---	---	---
Tc-99	3.3E-03	6.4E-08	---	---	---	---
Th-228	3.0E+00	8.7E-05	1.5E+00	3.9E-05	1.5E+00	3.9E-05
Th-229	3.8E-03	5.4E-08	---	---	---	---
Th-230	3.3E-03	3.2E-08	---	---	---	---
Th-232	1.9E+01	1.1E+00	1.6E+00	7.4E-05	1.6E+00	7.4E-05
U-233	1.2E-01	3.6E-03	---	---	---	---
U-234	5.1E+01	4.9E+00	3.4E-01	3.1E-05	3.4E-01	3.1E-05
U-235	5.8E+01	2.2E-01	4.9E+00	4.1E-06	2.5E+01	1.3E-04
U-236	1.9E-03	2.3E-05	---	---	---	---
U-238	8.0E+01	1.2E+01	6.0E+00	1.1E-04	2.9E+00	9.6E-05

--- = None

[a] *Includes waste disposed of from September 27, 1988 through the end of 2044.*

The total volumes and activities projected for the composite analysis are listed in Table 47 for the pits and shafts. Separate inventories are provided for surface-contaminated waste, soils, and concrete and sludge and are summed over all pits and shafts receiving waste from 1957–2044. Tables 48 and 49 list the projected radionuclide-specific inventories for the pits and shafts, respectively. The waste volumes listed in these tables represent the quantities of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of these volumes exceeds the total volume of waste placed in the pits and shafts. All activities listed in Tables 47–49 represent as-disposed activities.

Table 47
Volumes and Activities for Waste Included in the MDA G Composite Analysis Inventory [a]

Waste Form by Type of Disposal Unit	Volume (m^3)	Activity (Ci)
Pits		
Surface-Contaminated Waste	2.0E+05	6.1E+04
Soil	1.2E+05	1.4E+02
Concrete and Sludge	2.3E+04	3.2E+03
Shafts		
Surface-Contaminated Waste	2.5E+03	3.8E+06
Soil	3.0E+01	1.3E+03
Concrete and Sludge	3.6E+01	1.3E+03

[a] *Includes waste disposed of since facility opened in 1957 through the end of 2044*

Table 48
Pit Radionuclide Inventories for Waste Included in the MDA G Composite Analysis [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ac-227	1.3E+00	9.3E-01	2.0E-01	1.4E-05	---	---
Ag-108m	2.0E+02	9.7E-04	---	---	---	---
Al-26	8.6E-02	1.6E-03	---	---	---	---
Am-241	3.0E+04	6.0E+01	4.0E+04	3.0E+00	7.2E+03	2.3E+03
Am-243	1.0E+03	4.7E-02	1.1E+02	9.1E-05	6.1E+01	5.9E-05
Ba-133	4.8E+02	4.3E-02	---	---	---	---
Be-10	9.8E+01	2.8E-02	---	---	---	---
Bi-207	1.9E+01	3.9E-02	---	---	---	---
Bk-247	1.0E+02	1.4E-06	---	---	---	---
C-14	7.2E+02	2.0E+01	3.8E+01	4.0E-05	1.4E+02	4.6E-03
Ca-41	9.9E+01	1.7E+00	---	---	---	---
Cf-249	3.4E+01	2.8E-03	---	---	---	---
Cf-251	2.3E-01	4.3E-03	---	---	---	---
Cf-252	9.4E-01	2.3E-02	---	---	---	---
Cl-36	9.9E+01	1.1E-01	---	---	---	---
Cm-243	5.3E+01	1.9E-04	2.6E+00	7.7E-08	7.3E+01	6.3E-05
Cm-244	2.1E+00	2.3E-03	7.2E-02	8.5E-10	---	---
Cm-245	---	---	---	---	1.4E+02	2.8E-04
Co-60	1.4E+04	1.5E+03	3.6E+04	1.1E+01	6.4E+02	9.1E-01
Cs-135	2.5E+02	7.1E-04	---	---	---	---
Cs-137	1.8E+04	1.3E+03	3.8E+04	5.7E+00	1.2E+03	2.8E+00
Eu-152	9.2E+02	8.1E-01	2.0E+04	1.5E-01	7.1E+01	4.3E-02
Eu-154	2.5E+03	1.1E-01	3.1E+02	1.9E-02	2.5E+02	6.1E-03
Gd-148	3.5E-01	6.1E-05	---	---	---	---
H-3	5.8E+03	9.7E+03	2.6E+04	3.0E+01	4.4E+02	3.8E+00
Ho-163	8.6E+01	5.6E+00	---	---	---	---

--- = None

[a] Includes waste disposed of since facility opened in 1957 through the end of 2044

Table 48 (Continued)
Pit Radionuclide Inventories for Waste Included in the MDA G Composite Analysis [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ho-166m	3.1E+01	4.1E-05	---	---	---	---
I-129	2.6E+02	1.1E-04	---	---	1.1E+02	6.0E-05
K-40	1.1E+03	4.8E-03	7.8E+02	1.1E-02	1.0E+02	5.6E-04
Kr-85	1.9E+03	2.1E+02	2.3E+02	1.6E-03	2.3E+02	7.2E-02
Lu-176	---	---	---	---	1.3E+00	1.0E-05
Mo-93	1.0E+00	1.2E-04	---	---	---	---
Nb-91	3.5E-01	3.1E-06	---	---	---	---
Nb-92	3.5E-01	1.8E-05	---	---	---	---
Nb-93m	3.6E+00	1.3E-04	2.6E+00	2.1E-08	8.4E-01	6.9E-09
Nb-94	2.8E+01	1.2E-01	3.3E+00	3.0E-08	1.5E+00	3.0E-08
Nd-144	3.5E-01	6.1E-08	---	---	---	---
Ni-59	4.6E+02	1.3E-02	3.0E+00	4.2E-05	1.2E+00	2.3E-05
Ni-63	7.5E+02	1.1E+01	7.5E+01	4.3E-02	1.5E+02	2.6E-02
Np-237	1.8E+03	2.0E-02	2.4E+01	2.1E-05	9.7E+01	3.8E-05
Os-194	2.5E+00	8.0E-07	---	---	---	---
Pa-231	2.0E+01	3.3E-04	3.0E+01	6.8E-05	---	---
Pb-210	5.4E+02	1.2E+00	1.4E+04	7.8E-02	8.2E+00	1.6E-02
Pm-145	9.1E+01	6.7E-01	---	---	---	---
Pu-236	3.5E-01	6.1E-09	---	---	---	---
Pu-238	2.9E+04	4.5E+03	5.7E+04	3.6E+00	6.8E+03	6.4E+02
Pu-239	4.7E+04	1.8E+03	6.6E+04	4.3E+01	1.0E+04	1.4E+02
Pu-240	1.4E+04	4.5E+02	1.9E+04	1.1E+00	5.4E+02	4.2E+00
Pu-241	1.4E+04	8.2E+03	6.7E+01	6.2E-01	1.0E+02	4.0E-02
Pu-242	1.3E+04	6.2E-02	1.1E+02	1.0E-04	3.7E+01	6.4E-05
Pu-244	---	---	---	---	3.8E+01	2.1E-05
Ra-226	9.9E+02	2.8E-01	4.8E+02	1.1E-02	4.5E+01	4.6E-04
Ra-228	1.3E+02	2.1E-01	1.4E+04	2.4E-02	9.7E+00	5.7E-05

--- = None

[a] Includes waste disposed of since facility opened in 1957 through the end of 2044

Table 48 (Continued)
Pit Radionuclide Inventories for Waste Included in the MDA G Composite Analysis [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Si-32	3.8E+00	7.5E-05	---	---	---	---
Sm-151	1.9E+03	8.2E-04	2.3E+02	7.0E-09	2.3E+02	2.8E-07
Sn-121m	1.8E+03	8.5E-02	2.3E+02	6.4E-07	2.3E+02	2.9E-05
Sn-126	1.8E+03	8.2E-03	2.3E+02	1.6E-07	2.3E+02	7.1E-06
Sr-90	7.1E+03	1.6E+03	5.7E+04	1.4E+00	7.7E+02	1.4E-01
Ta-182	5.9E+02	7.7E+00	---	---	---	---
Tb-157	3.4E+01	2.7E-07	---	---	---	---
Tc-97	6.6E+00	1.3E-05	---	---	---	---
Tc-99	1.5E+03	1.7E+00	9.4E+01	1.9E-03	1.1E+02	1.2E-03
Th-228	5.9E+02	5.6E-03	2.4E+02	5.9E-04	7.0E+01	5.9E-05
Th-229	1.9E+02	2.1E-03	1.7E-01	5.2E-07	1.7E-01	5.2E-07
Th-230	4.2E+02	2.6E+01	2.1E+02	4.2E-03	3.4E+01	2.4E-05
Th-232	3.2E+03	1.2E-01	1.6E+03	6.0E-02	5.6E+02	1.1E-02
Ti-44	3.5E+02	4.3E-03	4.8E+00	3.8E-07	1.5E+00	1.2E-07
U-232	8.2E+01	3.7E-03	1.0E-01	5.7E-05	1.0E-01	5.7E-05
U-233	2.5E+02	7.9E-02	4.0E+00	3.4E-04	2.5E+03	6.1E+00
U-234	8.7E+03	1.1E+01	2.0E+04	1.1E+00	1.1E+03	2.4E-01
U-235	2.5E+04	2.3E+00	2.0E+04	1.1E-01	3.4E+03	1.0E-01
U-236	1.3E+03	1.3E-03	6.1E+00	6.0E-05	6.0E+00	6.0E-05
U-238	2.0E+04	5.1E+01	2.3E+04	5.8E+00	1.1E+03	5.4E-01
Zr-93	6.9E-01	1.2E-07	---	---	---	---

--- = None

[a] Includes waste disposed of since facility opened in 1957 through the end of 2044

Table 49
Shaft Radionuclide Inventories for Waste Included in the MDA G Composite Analysis [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Ac-227	3.3E-03	3.2E-06	---	---	---	---
Ag-108m	9.2E+00	2.7E+01	---	---	---	---
Am-241	5.6E+01	5.5E-02	3.6E+00	5.4E-04	2.5E+01	6.9E-02
Am-243	2.1E-01	2.0E-02	8.7E-02	1.5E-18	8.7E-02	1.5E-18
Ba-133	3.4E-02	8.1E-03	---	---	---	---
Bi-207	7.0E-01	3.1E-04	---	---	---	---
C-14	1.1E+02	9.9E+01	---	---	---	---
Cf-252	2.5E-01	6.3E+01	---	---	---	---
Cl-36	3.3E-03	6.1E-08	---	---	---	---
Cm-244	5.0E-01	1.9E-01	---	---	---	---
Co-60	6.9E+02	1.7E+04	6.3E+00	5.2E+02	6.3E+00	5.2E+02
Cs-135	2.7E+00	4.5E-06	---	---	---	---
Cs-137	3.4E+01	1.5E+03	2.6E+00	4.5E-05	---	---
Eu-152	7.9E+00	1.3E-01	---	---	---	---
Eu-154	2.1E+01	1.4E-01	---	---	---	---
Gd-148	3.3E-03	4.7E-08	---	---	---	---
H-3	8.6E+02	3.6E+06	3.0E+00	1.0E+02	4.5E-01	1.0E+02
Ho-163	1.1E+01	4.3E-01	---	---	---	---
K-40	6.4E+00	2.6E-06	---	---	---	---
Kr-85	2.3E+01	1.3E+03	---	---	---	---
Mo-93	1.5E+02	6.7E-02	5.0E+00	6.5E-03	5.0E+00	6.5E-03
Nb-92	1.1E-01	4.0E-03	---	---	---	---
Ni-59	1.0E+01	7.7E+00	5.0E+00	3.8E+00	5.0E+00	3.8E+00
Ni-63	2.5E+02	6.1E+03	5.0E+00	4.4E+02	5.0E+00	4.4E+02
Np-237	6.6E+00	2.2E-04	8.7E-02	1.5E-18	8.7E-02	1.5E-18
Pa-231	6.4E+00	3.1E-07	---	---	---	---

--- = None

[a] Includes waste disposed of since facility opened in 1957 through the end of 2044

Table 49 (Continued)
Shaft Radionuclide Inventories for Waste Included in the MDA G Composite Analysis [a]

Radionuclide	Waste Form					
	Surface-Contaminated Waste		Soil		Concrete and Sludge	
	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)	Volume (m^3)	Activity (Ci)
Pb-210	6.4E+00	1.6E-07	---	---	---	---
Pu-238	6.7E+01	7.2E+00	3.6E+00	1.0E-02	2.5E+01	2.4E-01
Pu-239	9.6E+01	1.2E+02	3.6E+00	6.1E-03	2.5E+01	6.9E-02
Pu-240	1.0E+01	3.7E+00	2.6E+00	1.6E-03	---	---
Pu-241	1.0E+01	5.7E+01	---	---	---	---
Pu-242	3.1E+00	3.3E-04	---	---	---	---
Ra-226	9.8E+00	7.3E+00	3.2E-01	1.3E-08	3.2E-01	1.3E-08
Sm-151	2.0E+01	4.9E-03	---	---	---	---
Sn-121m	2.0E+01	5.1E-01	---	---	---	---
Sn-126	2.0E+01	1.3E-01	---	---	---	---
Sr-90	2.3E+01	1.9E+03	2.6E+00	9.0E-05	---	---
Ta-182	1.6E+01	9.3E+02	---	---	---	---
Tc-99	3.3E-03	6.4E-08	---	---	---	---
Th-228	3.0E+00	8.7E-05	1.5E+00	3.9E-05	1.5E+00	3.9E-05
Th-229	3.8E-03	5.4E-08	---	---	---	---
Th-230	3.3E-03	3.2E-08	---	---	---	---
Th-232	2.8E+01	4.2E+00	1.6E+00	7.4E-05	1.6E+00	7.4E-05
U-232	3.8E-03	2.1E-01	---	---	---	---
U-233	6.8E-01	5.5E+00	---	---	---	---
U-234	7.5E+01	5.6E+00	5.6E-01	2.8E-02	3.4E-01	3.1E-05
U-235	1.0E+02	1.2E+00	5.2E+00	1.1E-03	2.5E+01	1.3E-04
U-236	5.3E-01	2.1E-04	---	---	---	---
U-238	1.8E+02	2.3E+01	6.7E+00	1.8E-01	2.9E+00	9.6E-05

--- = None

[a] *Includes waste disposed of since facility opened in 1957 through the end of 2044*

5.0 References

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Attachment I
Bases for Radionuclide Inclusion in the Material Disposal Area G Inventory

Active institutional control will be exercised over Material Disposal Area (MDA) G for a period of 100 years following the end of disposal operations. During this period, persons will be prevented from intruding onto the site for extended periods of time and measures will be taken to ensure proper facility function. As a result of these actions, there will be little or no potential for exposures from radionuclides with extremely short half-lives.

Because of this, most radionuclides with half-lives of 5 years or less were excluded from the MDA G inventory. The primary exception to this is radionuclides that are daughters of parents with half-lives greater than 5 years. Table I-1 lists all radionuclides that were encountered in the inventory characterization update and their half-lives, briefly describes their decay characteristics, and specifies whether, or in what manner, the constituents were included in the final inventory.

The radionuclides listed in the table are referred to as either short or long-lived. For the purpose of presenting the decay information, short-lived refers to isotopes with half-lives of less than 1 year, while radionuclides with half-lives of 1 yr or more are referred to as long-lived.

Several radionuclides in Table I-1 have half-lives of 5 years or less but decay to form daughter products with much longer half-lives. The potential exists for these long-lived daughter products to make significant contributions to the long-term risks posed by the disposal facility to human health and safety. These contributions were expected to be negligible because of the very small activities associated with the longer-lived isotopes. Nevertheless, screening calculations were conducted to ensure that eliminating the long-lived daughters and their short-lived precursors would not compromise the doses projected for the performance assessment and composite analysis.

The screening evaluation modeled the decay of the short-lived daughters under consideration and the ingrowth of their long-lived daughter products. These calculations were conducted using the composite analysis inventory projections, summed over all disposal units that have been or will be used for the disposal of waste at MDA G. The decay and ingrowth calculations were performed over a 1,000-year period and used, in conjunction with the total waste volume, to estimate radionuclide concentrations in the waste as a function of time. The projected concentrations were used to conservatively estimate exposures to a hypothetical person who ingested small quantities of waste, inhaled suspended contamination, and received direct radiation from the waste.

The exposure parameters that were used to conduct the screening evaluation are summarized in Table I-2. The internal and external dose conversion factors used in the assessment were taken from Federal Guidance Reports 11 and 12, respectively (EPA, 1988 and 1993). Direct radiation dose conversion factors for soil contaminated to an infinite depth were selected for the analysis.

Table I-1
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Ac-227	2.2E+01	Decays to form short-lived Fr-223 and Th-227; daughter of long-lived Pa-231. Included in final inventory.
Ac-228	7.0E-04	Decays to form long-lived Th-228; daughter of long-lived Ra-228. Included in final inventory as a short-lived daughter of Ra-228.
Ag-105	1.1E-01	Decays to form stable Pd-105; daughter of short-lived Ag-105m and Cd-105. Excluded from final inventory.
Ag-108m	4.2E+02	Decays to form short-lived Ag-108 and stable Pd-108; included in final inventory.
Ag-110m	6.8E-01	Decays to form short-lived Ag-110 and stable Cd-110; excluded from final inventory.
Ag-111	2.0E-02	Decays to form stable Cd-111; daughter of short-lived Pd-111. Excluded from final inventory.
Al-26	7.1E+05	Decays to form stable Mg-26; daughter of short-lived Si-26. Included in final inventory.
Am-240	5.8E-03	Decays to form long-lived Np-236 and Pu-240; inventory of long-lived daughters expected to be negligible. Excluded from final inventory.
Am-241	4.3E+02	Decays to form long-lived Np-237; daughter of long-lived Pu-241. Included in final inventory.
Am-242	1.8E-03	Decays to form short-lived Cm-242 and long-lived Pu-242; daughter of long-lived Am-242m. Inventory of long-lived daughter expected to be negligible; included in final inventory as a short-lived daughter of Am-242m.
Am-243	7.4E+03	Decays to form short-lived Np-239; daughter of long-lived Cm-243 and short-lived Pu-243. Included in final inventory.
As-72	3.0E-03	Decays to form stable Ge-72; daughter of short-lived Se-72. Excluded from final inventory.
As-73	2.2E-01	Decays to form stable Ge-73; daughter of short-lived Se-73. Excluded from final inventory.
As-74	4.9E-02	Decays to form stable Ga-74 and Se-74; excluded from final inventory.
Au-194	4.3E-03	Decays to form stable Pt-194; daughter of long-lived Hg-194. Included in final inventory as a short-lived daughter of Hg-194.
Au-195	5.1E-01	Decays to form stable Pt-195; daughter of short-lived Hg-195m. Excluded from final inventory.
Ba-133	1.1E+01	Decays to form stable Cs-133; daughter of short-lived Ba-133m. Included in final inventory.
Ba-137m	4.9E-06	Decays to form stable Ba-137; daughter of long-lived Cs-137. Included in final inventory as a short-lived daughter of Cs-137.
Ba-139	1.6E-04	Decays to form stable La-139; daughter of short-lived Ce-139. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Ba-140	3.5E-02	Decays to form short-lived La-140; daughter of short-lived Cs-140. Excluded from final inventory.
Be-7	1.5E-01	Decays to form stable Li-7; excluded from final inventory.
Be-10	1.5E+06	Decays to form stable B-10; included in final inventory.
Bi-207	3.2E+01	Decays to form stable Pb-207; daughter of short-lived At-211. Included in final inventory.
Bi-210	1.4E-02	Decays to form short-lived Po-210; daughter of long-lived Pb-210. Included in final inventory as a short-lived daughter of Pb-210.
Bi-211	4.1E-06	Decays to form short-lived Po-211 and Tl-207; daughter of short-lived Pb-211. Included in final inventory as a short-lived daughter of Ac-227.
Bi-212	1.2E-04	Decays to form short-lived Po-212 and Tl-208; daughter of short-lived Pb-212. Included in final inventory as a short-lived daughter of Th-228.
Bi-214	3.8E-05	Decays to form short-lived Po-214; daughter of short-lived Pb-214. Included in final inventory as a short-lived daughter of Ra-226.
Bk-247	1.4E+03	Decays to form long-lived Am-243; included in final inventory.
Bk-249	9.0E-01	Decays to form long-lived Cf-249; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
Br-76	1.8E-03	Decays to form stable Se-76; daughter of short-lived Kr-76. Excluded from final inventory.
Br-77	6.5E-03	Decays to form stable Se-77; daughter of short-lived Kr-77. Excluded from final inventory.
Br-82	4.0E-03	Decays to form stable Kr-82; daughter of short-lived Br-82m. Excluded from final inventory.
C-14	5.7E+03	Decays to form stable N-14; included in final inventory.
Ca-41	1.0E+05	Decays to form stable K-41; daughter of short-lived Sc-41. Included in final inventory.
Ca-45	4.5E-01	Decays to form stable Sc-45; daughter of short-lived K-45. Excluded from final inventory.
Cd-109	1.3E+00	Decays to form short-lived Ag-109m and stable Ag-109; daughter of short-lived In-109. Excluded from final inventory.
Cd-113m	1.4E+01	Decays to form long-lived Cd-113 and stable In-113; daughter of short-lived Ag-113. Included in final inventory.
Cd-115	6.1E-03	Decays to form short-lived In-115m and long-lived In-115; daughter of short-lived Ag-115. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Ce-137	1.0E-03	Decays to form long-lived La-137; daughter of short-lived Ce-137m. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Ce-139	3.8E-01	Decays to form stable La-139; daughter of short-lived Ce-139m. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Ce-141	8.9E-02	Decays to form stable Pr-141; daughter of short-lived La-141. Excluded from final inventory.
Ce-144	7.8E-01	Decays to form short-lived Pr-144; daughter of short-lived La-144. Excluded from final inventory.
Cf-249	3.5E+02	Decays to form long-lived Cm-245; daughter of short-lived Bk-249. Included in final inventory.
Cf-251	9.0E+02	Decays to form long-lived Cm-247; daughter of short-lived Bk-241 and Fm-255. Included in final inventory.
Cf-252	2.6E+00	Decays to form long-lived Cm-248; daughter of short-lived Fm-256. Included in final inventory.
Cl-36	3.0E+05	Decays to form stable Ar-36 and S-36; included in final inventory.
Cm-242	4.5E-01	Decays to form long-lived Pu-238; daughter of short-lived Am-242. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Cm-243	2.9E+01	Decays to form long-lived Pu-239; included in final inventory.
Cm-244	1.8E+01	Decays to form long-lived Pu-240; daughter of short-lived Am-244 and Cf-248. Included in final inventory.
Cm-245	8.5E+03	Decays to form long-lived Pu-241; daughter of short-lived Am-245 and long-lived Cf-249. Included in final inventory.
Co-56	2.1E-01	Decays to form stable Fe-56; daughter of short-lived Ni-56. Excluded from final inventory.
Co-57	7.4E-01	Decays to form stable Fe-57; daughter of short-lived Ni-57. Excluded from final inventory.
Co-58	1.9E-01	Decays to form stable Fe-58; excluded from final inventory.
Co-60	5.3E+00	Decays to form stable Ni-60; daughter of long-lived Fe-60. Included in final inventory.
Cr-51	7.6E-02	Decays to form stable V-51; daughter of short-lived Mn-51. Excluded from final inventory.
Cs-134	2.1E+00	Decays to form stable Ba-134 and Xe-134; excluded from final inventory.
Cs-135	2.3E+06	Decays to form stable Ba-135; daughter of short-lived Xe-135. Included in final inventory.
Cs-136	3.6E-02	Decays to form stable Ba-136; excluded from final inventory.
Cs-137	3.0E+01	Decays to form short-lived Ba-137m; daughter of short-lived Xe-133. Included in final inventory.
Cu-67	7.1E-03	Decays to form stable Zn-67; daughter of short-lived Ni-67. Excluded from final inventory.
Dy-154	3.0E+06	Decays to form long-lived Gd-150; daughter of short-lived Ho-154m. Included in final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Dy-159	4.0E-01	Decays to form stable Tb-159; daughter of short-lived Ho-159. Excluded from final inventory.
Eu-149	2.6E-01	Decays to form stable Sm-149; daughter of short-lived Gd-149. Excluded from final inventory.
Eu-150	3.6E+01	Decays to form stable Sm-150; included in final inventory.
Eu-152	1.4E+01	Decays to form long-lived Gd-152 and stable Sm-152; daughter of short-lived Eu-152m. Included in final inventory.
Eu-154	8.6E+00	Decays to form stable Gd-154 and stable Sm-154; daughter of short-lived Eu-154m. Included in final inventory.
Eu-155	4.8E+00	Decays to form stable Gd-155; daughter of short-lived Sm-155. Excluded from final inventory.
Eu-156	4.2E-02	Decays to form stable Gd-156; daughter of short-lived Sm-146. Excluded from final inventory.
Eu-158	8.7E-05	Decays to form stable Gd-158; daughter of short-lived Sm-158. Excluded from final inventory.
Fe-52	9.5E-04	Decays to form short-lived Mn-52 and Mn-52m; daughter of short-lived Co-52. Excluded from final inventory.
Fe-55	2.7E+00	Decays to form stable Mn-55; daughter of short-lived Co-55. Excluded from final inventory.
Fe-59	1.2E-01	Decays to form stable Co-59; daughter of short-lived Mn-59. Excluded from final inventory.
Ga-68	1.3E-04	Decays to form stable Zn-68; daughter of short-lived Ge-68. Excluded from final inventory.
Gd-146	1.3E-01	Decays to form short-lived Eu-146 and, ultimately, long-lived Sm-146; daughter of short-lived Tb-146. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Gd-148	7.5E+01	Decays to form stable Sm-144; daughter of short-lived Tb-148. Included in final inventory.
Gd-150	1.8E+06	Decays to form long-lived Sm-146; daughter of short-lived Tb-150. Included in final inventory.
Gd-151	3.4E-01	Decays to form stable Eu-151 and long-lived Sm-147; daughter of short-lived Tb-151. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Gd-152	1.1E+14	Decays to form long-lived Sm-148; daughter of short-lived Tb-152. Included in final inventory.
Gd-153	6.6E-01	Decays to form stable Eu-153; daughter of short-lived Tb-153. Excluded from final inventory.
Ge-68	7.4E-01	Decays to form short-lived Ga-68; daughter of short-lived As-68. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
H-3	1.2E+01	Decays to form stable He-3; included in final inventory.
Hf-172	1.9E+00	Decays to form short-lived Lu-172; daughter of short-lived Ta-172. Excluded from final inventory.
Hf-175	1.9E-01	Decays to form stable Lu-175; daughter of short-lived Ta-175. Excluded from final inventory.
Hf-178m	3.1E+01	Decays to form stable Hf-178; excluded from final inventory.
Hf-181	1.2E-01	Decays to form stable Ta-181; daughter of short-lived Lu-181. Excluded from final inventory.
Hg-203	1.3E-01	Decays to form stable Tl-203; daughter of short-lived Au-203. Excluded from final inventory.
Ho-163	4.6E+03	Decays to form stable Dy-163; daughter of short-lived Er-173. Included in final inventory.
Ho-166	3.1E-03	Decays to form stable Er-166; daughter of short-lived Dy-166. Excluded from final inventory.
Ho-166m	1.2E+03	Decays to form stable Er-166; included in final inventory.
I-125	1.6E-01	Decays to form stable Te-125; daughter of short-lived Xe-125. Excluded from final inventory.
I-129	1.6E+07	Decays to form stable Xe-129; daughter of short-lived Te-129. Included in final inventory.
I-131	2.2E-02	Decays to form stable Xe-131 and short-lived Xe-131m; daughter of short-lived Te-125. Excluded from final inventory.
In-114m	1.4E-01	Decays to form stable Cd-114 and short-lived In-114; excluded from final inventory.
In-115m	5.1E-04	Decays to form long-lived In-115 and stable Sn-115; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
Ir-192	2.0E-01	Decays to form stable Os-194 and Pt-194; daughter of short-lived Ir-192m. Excluded from final inventory.
Ir-194	2.2E-03	Decays to form stable Pt-194; daughter of short-lived Ir-194m and long-lived Os-194. Included in final inventory as a short-lived daughter of Os-194.
K-40	1.3E+09	Decays to form stable Ar-40 and stable Ca-40; included in final inventory.
Kr-81	2.3E+05	Decays to form stable Br-81; daughter of short-lived Rb-81. Included in final inventory.
Kr-85	1.1E+01	Decays to form stable Rb-85; daughter of Kr-85m. Included in final inventory.
La-137	6.0E+04	Decays to form stable Ba-137; daughter of short-lived Ce-137. Included in final inventory.
La-140	1.7E+00	Decays to form stable Ce-140; daughter of short-lived Ba-140. Excluded from final inventory.
Lu-172	1.8E-02	Decays to form stable Yb-172; daughter of short-lived Hf-172. Excluded from final inventory.
Lu-172m	7.0E-06	Decays to form short-lived Lu-172; excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Lu-173	1.4E+00	Decays to form stable Yb-173; daughter of short-lived Hf-173. Excluded from final inventory.
Lu-174	3.3E+00	Decays to form stable Yb-174; daughter of short-lived Lu-174m. Excluded from final inventory.
Lu-176	3.8E+10	Decays to form stable Hf-176; included in final inventory.
Lu-177	1.8E-02	Decays to form stable Hf-177; daughter of short-lived Yb-177. Excluded from final inventory.
Mn-52	1.5E-02	Decays to form stable Cr-52; daughter of short-lived Fe-52. Excluded from inventory.
Mn-52m	4.0E-05	Decays to form stable Cr-52 and short-lived Mn-52; daughter of short-lived Fe-52. Excluded from final inventory.
Mn-54	8.6E-01	Decays to form stable Cr-54 and stable Fe-54; excluded from final inventory.
Mn-56	2.9E-04	Decays to form stable Fe-56; daughter of short-lived Cr-56. Excluded from final inventory.
Mo-93	3.5E+03	Decays to form stable Nb-93; daughter of short-lived Tc-93. Included in final inventory.
Mo-99	7.5E-03	Decays to form long-lived Tc-99 and short-lived Tc-99m; daughter of short-lived Nb-99. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Na-22	2.6E+00	Decays to form stable Ne-22; daughter of short-lived Mg-22. Excluded from final inventory.
Na-24	1.7E-03	Decays to form stable Mg-24; daughter of short-lived Ne-24. Excluded from final inventory.
Nb-91	7.0E+02	Decays to form stable Zr-91; daughter of short-lived Mo-91 and Nb-91m. Included in final inventory.
Nb-91m	1.7E-01	Decays to form long-lived Nb-91 and stable Zr-91; daughter of short-lived Mo-91. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Nb-92	3.5E+07	Decays to form stable Zr-92; included in final inventory.
Nb-92m	2.8E-02	Decays to form stable Zr-92; excluded from final inventory.
Nb-93m	1.6E+01	Decays to form stable Nb-93; included in final inventory.
Nb-94	2.0E+04	Decays to stable Mo-94; included in final inventory.
Nb-95	9.6E-02	Decays to form stable Mo-95; daughter of short-lived Zr-95. Excluded from final inventory.
Nd-144	2.4E+15	Decays to stable Ce-140; daughter of short-lived Pm-144, Pr-144, and Pr-144m. Included in final inventory.
Nd-147	3.0E-02	Decays to form short-lived Pm-147 and, ultimately, long-lived Sm-147; daughter of short-lived Pr-147. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Ni-56	1.6E-02	Decays to form short-lived Co-56; excluded from final inventory.

[a] Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Ni-57	4.1E-03	Decays to form short-lived Co-57; daughter of short-lived Cu-57. Excluded from final inventory.
Ni-59	7.6E+04	Decays to form stable Co-59; daughter of short-lived Cu-59. Included in final inventory.
Ni-63	1.0E+02	Decays to form stable Cu-63; daughter of short-lived Co-63. Included in final inventory.
Ni-65	2.9E-04	Decays to form stable Cu-65; daughter of short-lived Co-65. Excluded from final inventory.
Np-235	1.1E+00	Decays to form long-lived U-235; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
Np-237	2.1E+06	Decays to form short-lived Pa-233; daughter of long-lived Am-241. Included in final inventory.
Np-239	6.5E-03	Decays to form long-lived Pu-239; daughter of long-lived Am-243. Included in final inventory as a short-lived daughter of Am-243.
Np-242	1.0E-05	Decays to form long-lived Pu-242; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
Os-194	6.0E+00	Decays to form short-lived Ir-194; included in final inventory.
P-32	3.9E-02	Decays to stable S-32; daughter of long-lived Si-32. Included in final inventory as a short-lived daughter of Si-32.
P-33	6.9E-02	Decays to form stable S-33; daughter of short-lived Si-33. Excluded from final inventory.
Pa-231	3.3E+04	Decays to form long-lived Ac-227; daughter of short-lived Th-231. Included in final inventory.
Pa-233	7.4E-02	Decays to form long-lived U-233; daughter of long-lived Np-237. Included in final inventory as a short-lived daughter of Np-237.
Pa-234	7.6E-04	Decays to form long-lived U-234; daughter of short-lived Pa-234m. Included in final inventory as a short-lived daughter of U-238.
Pa-234m	2.2E-06	Decays to form long-lived U-234; daughter of short-lived Th-234. Included in final inventory as a short-lived daughter of U-238.
Pb-203	5.9E-03	Decays to form stable Tl-203; daughter of short-lived Bi-203. Excluded from final inventory.
Pb-210	2.2E+01	Decays to form short-lived Bi-210; daughter of short-lived Po-214. Included in final inventory.
Pb-211	6.9E-05	Decays to form short-lived Bi-211; daughter of short-lived Po-211. Included in final inventory as a short-lived daughter of Ac-227.
Pb-212	1.2E-03	Decays to form short-lived Bi-212; daughter of short-lived Po-216. Included in final inventory as a short-lived daughter of Th-228.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Pb-214	5.1E-05	Decays to form short-lived Bi-214; daughter of short-lived Po-218. Included in final inventory as a short-lived daughter of Ra-226.
Pd-107	6.5E+06	Decays to form stable Ag-107; daughter of short-lived Rh-107. Included in final inventory.
Pm-143	7.3E-01	Decays to form stable Nd-143; daughter of short-lived Sm-143. Excluded from final inventory.
Pm-145	1.8E+01	Decays to form stable Nd-145 and stable Pr-141; daughter of short-lived Sm-145. Included in final inventory.
Pm-146	5.5E+00	Decays to form stable Nd-146 and long-lived Sm-146. Included in final inventory.
Pm-147	2.6E+00	Decays to form long-lived Sm-147; daughter of short-lived Nd-147. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Po-210	3.8E-01	Decays to form stable Pb-206; daughter of short-lived Bi-210. Included in final inventory as a short-lived daughter of Pb-210.
Pu-233	4.0E-05	Decays to form short-lived Np-233 and U-229, and ultimately forms long-lived U-233; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
Pu-234	1.0E-03	Decays to form short-lived Np-234 and U-230; the Np-234 decays to form long-lived U-234 while the U-230 ultimately forms long-lived Pb-210. Inventory of long-lived daughters expected to be negligible; excluded from final inventory.
Pu-236	2.9E+00	Decays to form long-lived U-232; included in final inventory.
Pu-238	8.8E+01	Decays to form long-lived U-234; daughter of short-lived Cm-242. Included in final inventory.
Pu-239	2.4E+04	Decays to form long-lived U-235; daughter of long-lived Cm-243 and short-lived Np-239. Included in final inventory.
Pu-240	6.6E+03	Decays to form long-lived U-236; daughter of long-lived Cm-244 and short-lived Np-240 and Np-240m. Included in final inventory.
Pu-241	1.4E+01	Decays to form long-lived Am-241; daughter of long-lived Cm-245. Included in final inventory.
Pu-242	3.8E+05	Decays to form long-lived U-238; daughter of long-lived Cm-246 and short-lived Am-242. Included in final inventory.
Pu-244	8.0E+07	Decays to form short-lived U-240; daughter of long-lived Cm-248. Included in final inventory.
Ra-223	3.1E-02	Decays to form short-lived Rn-219; daughter of short-lived Fr-223 and Th-227. Included in final inventory as a short-lived daughter of Ac-227.
Ra-224	1.0E-02	Decays to form short-lived Rn-220; daughter of long-lived Th-228. Included in final inventory as a short-lived daughter of Th-228.
Ra-226	1.6E+03	Decays to form short-lived Rn-222; daughter of long-lived Th-230. Included in final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Ra-228	5.8E+00	Decays to form short-lived Ac-228; daughter of long-lived Th-232. Included in final inventory.
Rb-82	2.4E-06	Decays to form stable Kr-82; daughter of short-lived Sr-82. Excluded from final inventory.
Rb-83	2.4E-01	Decays to form short-lived Kr-83m and stable Kr-83; daughter of short-lived Sr-83. Excluded from final inventory.
Rb-84	9.0E-02	Decays to form stable Kr-84 and Sr-84; excluded from final inventory.
Rb-86	5.1E-02	Decays to form stable Kr-86 and Sr-86; excluded from final inventory.
Re-183	1.9E-01	Decays to form long-lived W-183; daughter of short-lived Os-183. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Re-184	1.0E-01	Decays to form long-lived W-184; daughter of short-lived Re-184m. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Re-184m	1.8E-01	Decays to form short-lived Re-184 and long-lived W-184; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
Re-188	1.9E-03	Decays to form stable Os-188; daughter of short-lived W-188. Excluded from final inventory.
Rh-97	5.9E-05	Decays to form short-lived Ru-97 and, ultimately, long-lived Tc-97; daughter of short-lived Pd-97. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Rh-99	4.4E-02	Decays to form stable Ru-99; daughter of short-lived Pd-99. Excluded from final inventory.
Rh-101	3.3E+00	Decays to form stable Ru-101; daughter of short-lived Rh-101m. Excluded from final inventory.
Rh-102	5.7E-01	Decays to form stable Pd-102 and Ru-102; daughter of short-lived Rh-102m. Excluded from final inventory.
Rh-102m	3.7E+00	Decays to form stable Ru-102 and short-lived Rh-102; excluded from final inventory.
Rh-106	9.5E-07	Decays to form stable Pd-106; daughter of short-lived Ru-106. Excluded from final inventory.
Rn-219	1.3E-07	Decays to form short-lived Po-215; daughter of short-lived Ra-223. Included in final inventory as a short-lived daughter of Ac-227.
Ru-103	1.1E-01	Decays to form stable Rh-103; daughter of short-lived Ru-103m and Tc-103. Excluded from final inventory.
Ru-106	1.0E+00	Decays to form short-lived Rh-106; daughter of Tc-106. Excluded from final inventory.
S-35	2.4E-01	Decays to form stable Cl-35; daughter of short-lived P-35. Excluded from final inventory.
Sb-124	1.6E-01	Decays to form stable Te-124; daughter of short-lived Sb-124m. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Sb-125	2.8E+00	Decays to form short-lived Te-125m and stable Te-125; daughter of short-lived Sn-125. Excluded from final inventory.
Sb-126	3.4E-02	Decays to form stable Te-126; daughter of long-lived Sn-126 and short-lived Sb-126m. Sb-126 inventory assigned to Sn-126.
Sc-43	4.5E-04	Decays to form stable Ca-43; daughter of short-lived Ti-43. Excluded from final inventory.
Sc-44	4.5E-04	Decays to form stable Ca-44; daughter of long-lived Ti-44. Included in final inventory as a short-lived daughter of Ti-44.
Sc-46	2.3E-01	Decays to form stable Ti-46; daughter of short-lived Sc-46m. Excluded from final inventory.
Sc-48	4.2E-04	Decays to form stable Ti-48; excluded from final inventory
Se-73	8.1E-04	Decays to form short-lived As-73; daughter of short-lived Br-73. Excluded from final inventory.
Se-75	3.3E-01	Decays to form stable As-75; daughter of short-lived Br-75. Excluded from final inventory.
Se-79	2.9E+05	Decays to form stable Br-79; daughter of short-lived As-79. Included in final inventory.
Si-32	1.6E+02	Decays to form short-lived P-32; daughter of short-lived Al-32. Included in final inventory.
Sm-145	9.3E-01	Decays to form long-lived Pm-145; daughter of short-lived Eu-145. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Sm-151	9.0E+01	Decays to form stable Eu-150; daughter of short-lived Pm-151. Included in final inventory.
Sn-113	3.2E-01	Decays to form short-lived In-113m and stable In-113; daughter of short-lived Sb-113. Excluded from final inventory.
Sn-119m	8.0E-01	Decays to form stable Sn-119; daughter of short-lived In-119. Excluded from final inventory.
Sn-121	3.1E-03	Decays to form stable Sb-121; daughter of short-lived In-121 and Sn-121m. Excluded from final inventory.
Sn-121m	4.4E+01	Decays to form stable Sb-121 and short-lived Sn-121; daughter of short-lived In-121. Included in final inventory.
Sn-123	3.5E-01	Decays to form stable Sb-123; daughter of short-lived In-123. Excluded from final inventory.
Sn-126	2.3E+05	Decays to form short-lived Sb-126 and Sb-126m; daughter of short-lived In-126. Included in final inventory.
Sr-82	6.9E-02	Decays to form short-lived Rb-82; daughter of short-lived Y-82. Excluded from final inventory.
Sr-85	1.8E-01	Decays to form stable Rb-85; daughter of short-lived Y-85. Excluded from final inventory.
Sr-89	1.4E-01	Decays to form short-lived Y-89m and stable Y-89; daughter of short-lived Rb-89. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Sr-90	2.9E+01	Decays to form short-lived Y-90; daughter of short-lived Rb-90. Included in final inventory.
Ta-179	1.8E+00	Decays to form stable Hf-179; daughter of short-lived W-179. Excluded from final inventory.
Ta-182	3.1E-01	Decays to form stable W-182; daughter of long-lived Hf-182. Excluded from final inventory because of the absence of Hf-182.
Ta-183	1.4E-02	Decays to form long-lived W-183; daughter of short-lived Hf-183. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Tb-157	7.0E+01	Decays to form stable Gd-157; daughter of short-lived Dy-157. Included in final inventory.
Tb-158	1.8E+02	Decays to form stable Dy-158 and Gd-158; included in final inventory.
Tc-95	2.3E-03	Decays to form stable Mo-95; daughter of short-lived Ru-95 and Tc-95m. Excluded from final inventory.
Tc-95m	1.7E-01	Decays to form stable Mo-95 and short-lived Tc-95; daughter of short-lived Ru-95. Excluded from final inventory.
Tc-97	4.2E+06	Decays to form stable Mo-97; daughter of short-lived Tc-97m. Included in final inventory.
Tc-99	2.1E+05	Decays to form stable Ru-99; daughter of short-lived Mo-99 and Tc-99m. Included in final inventory.
Tc-99m	6.9E-04	Decays to form stable Ru-99 and long-lived Tc-99; daughter of short-lived Mo-99. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Te-125m	1.6E-01	Decays to form stable Te-125; excluded from final inventory.
Te-129m	9.2E-02	Decays to form long-lived I-129 and short-livedTe-129; daughter of short-lived Sb-129. Inventory of long-lived daughter expected to be negligible; excluded from final inventory.
Th-227	5.1E-02	Decays to form short-lived Ra-223; daughter of long-lived Ac-227. Included as a short-lived daughter of Ac-227.
Th-228	1.9E+00	Decays to form short-lived Ra-224; daughter of short-lived Ac-228. Included in final inventory.
Th-229	7.3E+03	Decays to form short-lived Ra-225; daughter of long-lived U-233. Included in final inventory.
Th-230	7.5E+04	Decays to form long-lived Ra-226; daughter of long-lived U-234. Included in final inventory.
Th-232	1.4E+10	Decays to form long-lived Ra-228; daughter of long-lived U-236. Included in final inventory.
Th-234	6.6E-02	Decays to form short-lived Pa-234m; daughter of long-lived U-238. Included in final inventory as a short-lived daughter of U-238.
Ti-44	6.0E+01	Decays to form short-lived Sc-44; daughter of short-lived V-44. Included in final inventory.
Tl-204	3.8E+00	Decays to form stable Hg-204 and long-lived Pb-204; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Tl-208	5.8E-06	Decays to form stable Pb-208; daughter of short-lived Bi-212. Included in final inventory as a short-lived daughter of Th-228.
Tm-170	3.5E-01	Decays to form stable Er-170 and Yb-170; excluded from final inventory.
Tm-171	1.9E+00	Decays to form stable Yb-171; daughter of short-lived Er-171. Excluded from final inventory.
U-232	7.0E+01	Decays to form long-lived Th-228; daughter of long-lived Pu-236. Included in final inventory.
U-233	1.6E+05	Decays to form long-lived Th-229; daughter of short-lived Pa-233. Included in final inventory.
U-234	2.5E+05	Decays to form long-lived Th-230; daughter of short-lived Pa-234 and Pa-234m and long-lived Pu-238. Included in final inventory.
U-235	7.0E+08	Decays to form short-lived Th-231; daughter of long-lived Pu-239. Included in final inventory.
U-236	2.3E+07	Decays to form long-lived Th-232; daughter of long-lived Pu-240. Included in final inventory.
U-237	2.1E-03	Decays to form long-lived Np-237; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
U-238	4.5E+09	Decays to form short-lived Th-234; daughter of long-lived Pu-242. Included in final inventory.
U-239	4.5E-05	Decays to form short-lived Np-239 and, ultimately, long-lived Pu-239; inventory of long-lived daughter expected to be negligible. Excluded from final inventory.
V-48	4.4E-02	Decays to form stable Ti-48; daughter of short-lived Cr-48. Excluded from final inventory.
V-49	9.1E-01	Decays to form stable Ti-49; daughter of short-lived Cr-49. Excluded from final inventory.
V-52	1.4E-06	Decays to form stable Cr-52; daughter of short-lived Ti-52. Excluded from final inventory.
W-181	3.3E-01	Decays to form stable Ta-181; daughter of short-lived Re-181. Excluded from final inventory.
W-185	2.0E-01	Decays to form stable Re-185; daughter of short-lived Ta-185. Excluded from final inventory.
Xe-133	1.4E-02	Decays to form stable Cs-133; daughter of short-lived I-133. Excluded from final inventory.
Y-88	2.9E-01	Decays to form stable Sr-88; daughter of short-lived Zr-88. Excluded from final inventory.
Y-90	7.3E-03	Decays to form stable Zr-90; daughter of long-lived Sr-90. Included in final inventory as a short-lived daughter of Sr-90.
Y-91	1.6E-01	Decays to form stable Zr-91; daughter of short-lived Sr-91. Excluded from final inventory.
Yb-169	8.8E-02	Decays to form stable Tm-169; daughter of short-lived Lu-169. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-1 (Continued)
Radionuclide Decay Characteristics and Bases for Inclusion in the MDA G Inventory

Radionuclide	Half-Life (yr)[a]	Decay Chain Characteristics and Assumptions
Zn-65	6.7E-01	Decays to form stable Cu-65; daughter of short-lived Ga-65. Excluded from final inventory.
Zn-69m	1.6E-03	Decays to form stable Ga-69 and short-lived Zn-69; excluded from final inventory.
Zn-72	7.4E-04	Decays to form short-lived Ga-72; daughter of short-lived Cu-72. Excluded from final inventory.
Zr-88	2.3E-01	Decays to form short-lived Y-88; daughter of short-lived Nb-88. Excluded from final inventory.
Zr-93	1.5E+06	Decays to form stable Nb-93; daughter of short-lived Y-93. Included in final inventory.
Zr-95	1.8E-01	Decays to form short-lived Nb-95 and Nb-95m; daughter of short-lived Y-95. Excluded from final inventory.

[a] *Primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

Table I-2
Exposure Parameters Used to Conduct the Screening Evaluation

Parameter	Units	Screening Value
Soil Ingestion Rate	mg/d	2.0E+02
Inhalation Rate	m^3/d	2.2E+01
Dust Loading	kg/m^3	1.0E-07
Site Occupancy Fraction	---	1.0E+00

The parameter values adopted for the screening evaluation were selected in a conservative manner. The soil ingestion rate of 200 mg/d (4.4×10^{-4} lb/d) exceeds the central estimate of 50 mg/d (1.1×10^{-4} lb/d) cited by the U.S. Environmental Protection Agency (EPA, 1997) and the range of 50 to 100 mg/d (1.1×10^{-4} to 2.2×10^{-4} lb/d) adopted by the National Council on Radiation Protection and Measurements (NCRP, 1999) for screening evaluations. However, 200 mg/d (4.4×10^{-4} lb/d) is equal to the soil ingestion rate cited by Simon (1998) for a rural lifestyle in a sparsely vegetated area. An inhalation rate of 22 m^3/d (77 ft^3/d) falls outside of the 10 to 20 m^3/d (35 to 70 ft^3/d) range provided as a long-term average for adult males by the EPA (1997), and is almost 50 percent greater than the average inhalation rate adopted by the Agency. The dust-loading factor used to estimate airborne radionuclide concentrations directly above the waste exceeds the value of 8.0×10^{-8} kg/m^3 (6.2×10^{-6} lb/ft^3) adopted by the NCRP (1999) to conduct screening assessments for residential scenarios. It is equal to the default value suggested by Anspaugh et al. (1975) in lieu of site-specific data. Dust loadings cited by Baes et al. (1984), the NCRP (1984), INEEL (1994), and DOE (1995) for various locations in the U.S. are all less than 1.0×10^{-7} kg/m^3 (7.8×10^{-6} lb/ft^3). Finally, it was conservatively assumed that the hypothetical receptor was present at the site 100 percent of the time.

The doses projected for the screening assessment decline from a peak exposure of 1.8 mrem/yr at the beginning of the simulation to 3.4×10^{-6} mrem/yr by the end of the 1,000-year period. Direct radiation from the waste is the primary contributor to the projected peak dose. All doses fall well within the performance objectives for the atmospheric pathway and all pathways exposure scenarios, 10 and 25 mrem/yr, respectively.

The doses calculated for the screening assessment are considered to be extremely conservative estimates of actual exposures for several reasons, some of which are considered here. First, the calculations assume the receptor is located directly above the disposal units at MDA G when, in fact, controls over the site will preclude long-term occupation of the site. Any such controls would force the receptor to occupy locations downwind of the site, where exposures would be orders of magnitude smaller. Second, the screening evaluation assumes there is no cover material placed over the waste and therefore does not consider the isolation of the waste afforded by the cover. With a cover in place, the amount of contamination available for direct ingestion and inhalation would be significantly smaller, limited to only that contamination deposited on the surface of the site by plants and animals penetrating into the waste. Additionally, the cover would shield the receptor from direct radiation emitted from the waste, reducing the projected exposures from that pathway by orders of magnitude. Third, the manner in which the screening assessment was conducted implicitly assumes that all waste was placed in the disposal units at the beginning of the 1,000-year simulation period. In fact, this waste was, or will be, disposed of over a period of several years during the disposal facility's operational period. Accounting for the decay and ingrowth of the radionuclides during the portion of the operational period that the waste resides at MDA G would result in smaller doses than those estimated by the screening assessment.

All told, the elimination of several short-lived radionuclides with long-lived daughters is not expected to compromise the performance assessment and composite analysis. Conservative estimates of the doses resulting from these isotopes are much less than acceptable limits and will be lower still under more realistic exposure conditions. On this basis, these radionuclides were excluded from the MDA G inventory.

Many of the radionuclides in Table I-1 are short-lived daughters of long-lived parents and, as such, are expected to be in secular equilibrium with said parents. Examples of these radionuclides include Ac-228, Ba-137m, and Bi-214. These short-lived isotopes are not listed in the tables provided in the main report, but will be included at the appropriate activities in the performance assessment and composite analysis modeling. An indication to this effect is provided in Table I-1.

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Attachment II

Pre-1971 Shaft Disposal Records for

Material Disposal Area G

This attachment summarizes the disposal records used to estimate the pre-1971 shaft inventories for the 2005 Material Disposal Area (MDA) G inventory characterization update. Table II-1 provides the date of disposal for each waste package, describes the waste, lists the radionuclide mass or activity associated with each package, and specifies the dimensions of the disposal shafts. Data are provided for waste that was placed in the shafts prior to 1971 and for which estimates of contaminant mass or volume were provided; some of the shafts were used for waste disposal after 1970. Table II-2 lists the total volumes of waste placed in the shafts that were active prior to 1971. All data provided in the tables were taken from Rogers (1977).

Table II-1
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
1	8/2/1966	Cell filters	1.0E+00	---	---	---	---
	8/10/1966	Irradiated Ta	---	---	3.0E+00	---	---
	8/15/1966	Cell trash	2.0E+00	---	---	---	---
	8/24/1966	Sr-90 waste	1.0E+00	---	---	---	---
	8/24/1966	Pu trash	1.0E+00	---	---	---	---
	8/25/1966	Irradiated Pu trash	2.5E+00	---	---	---	---
	9/14/1966	Np-237 foil	---	---	---	2.0E-01	---
	9/14/1966	Irradiated Pu	---	---	---	1.0E+00	---
	9/16/1966	Pu, Ce, Co waste	1.5E+00	---	---	---	---
	9/22/1966	Co-60	---	---	4.0E+00	---	---
	9/22/1966	Ce-137	---	---	5.0E-01	---	---
	9/27/1966	Irradiated Pu	1.5E+02	---	---	---	---
	10/7/1966	Cell waste	1.0E+00	---	---	---	---
	10/25/1966	Irradiated metal	---	1.0E+00	---	---	---
	10/27/1966	Irradiated metal	1.0E+00	---	---	---	---
	11/7/1966	Cell filter	1.0E+00	---	---	---	---

Source: Rogers. 1977

--- = No data
FP = Fission products
GETR = General Electric Test Reactor
MFP = Mixed-fission product
OWREX = Omega West Reactor Experiment
SS = Stainless steel
MAP = Mixed-activation product
PTC = Plasma thermocouple
LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content: MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
1 (Cont.)	11/8/1966	Irradiated Al	---	1.0E+00	---	---	---
	11/9/1966	H-3 waste	---	---	---	---	1.5E+02
	1/18/1967	Co-60 source	---	---	2.0E+00	---	---
	1/20/1967	U-235 metal	---	---	---	---	---
2	6/15/1966	Irradiated Pu cell waste	1.4E+01	---	---	---	---
	9/27/1966	Irradiated Pu cell waste	1.1E+03	---	---	---	---
	12/8/1966	Irradiated metal	1.0E+00	---	---	---	---
	12/20/1966	U-233 and U-235	---	---	---	---	---
	1/17/1967	PTC waste	6.1E+01	---	---	---	---
	1/18/1967	Co-60 waste	---	---	4.0E+00	---	---
	1/18/1967	Vacuum filter	2.5E+00	---		---	---
	1/19/1967	Irradiated metal	1.0E+00	---		---	---
	3/7/1967	Po-210 sources	---	---	1.0E-01	---	---
	3/10/1967	Co-60 source	---	---	4.5E+00	---	---
	4/14/1967	Co-60 sources	---	---	5.0E-01	---	---
	4/17/1967	U-235 and FP waste	1.0E+00	---	---	---	---
	5/15/1967	Co-57, La waste	---	1.0E+00	---	---	---

Source: Rogers, 1977

--- = No data | *MFP = Mixed-fission product* | *MAP = Mixed-activation product*

FP = Fission products | *OWREX = Omega West Reactor Experiment* | *PTC = Plasma thermocouple*

GETR = General Electric Test Reactor | *SS = Stainless steel* | *LAMPRE = Los Alamos Molten Plutonium Reactor Experiment*

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content: MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
3	1/31/1967	Pu-contaminated Na	2.0E+02	---	---	---	---
	1/31/1967	Pu-contaminated Na	8.0E+00	---	---	---	---
	3/30/1967	Pu-239 contaminated squibbs	---	---	---	1.5E+02	---
	4/12/1967	Irradiated thermocouple	---	8.0E-01	---	---	---
	5/11/1967	Irradiated metal	2.0E+00	---	---	---	---
	8/15/1967	Irradiated Ta	---	---	5.0E-01	---	---
	8/23/1967	Cell waste - U-235 and FP	5.0E+00	---	---	---	---
	11/1/1967	D-38 and U-235	---	---	---	---	---
	11/9/1967	Irradiated metal	1.0E-02	---	---	---	---
4	4/5/1967	Control rods	---	6.0E+00	---	---	---
	6/7/1967	Pu and Ta cell trash	1.0E+00	---	---	---	---
	6/21/1967	Pu contaminated cell waste	1.0E+00	---	---	---	---
	7/19/1967	Co-60, Cs-137, U-233- and U-235 sources	1.0E+00	---	---	---	---
	7/26/1967	Pu, U, Cm, Np and Th sources	1.0E+00	---	---	---	---
	---	Pu-239	---	---	---	1.1E-01	---
	---	Pu-240	---	---	---	3.0E-03	---

Source: Rogers, 1977

--- = No data
FP = Fission products
GETR = General Electric Test Reactor
MFP = Mixed-fission product
OWREX = Omega West Reactor Experiment
SS = Stainless steel
MAP = Mixed-activation product
PTC = Plasma thermocouple
LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
4 (Cont.)	---	Pu-241	---	---	---	5.0E-05	---
	---	Np-237	---	---	---	6.0E-03	---
	---	Cm-244	---	---	---	2.9E-06	---
	---	U-233	---	---	---	---	---
	---	U-234	---	---	---	---	---
	---	U-236	---	---	---	---	---
	---	Th-230	---	---	---	---	---
	8/11/1967	Pu-239 contaminated U-235	---	---	---	---	---
	9/14/1967	End boxes	---	1.0E+00	---	---	---
5	8/7/1967	Cell trash	---	---	---	5.0E-01	---
	10/2/1967	U-235	---	---	---	---	---
	10/30/1967	Sample elements	1.0E+01	---	---	---	---
	10/37/67	Sample elements	1.0E+01	---	---	---	---
	11/1/1967	Sample elements	5.0E+00		---	---	---
	11/29/1967	U-235 contaminated BF3 chambers	---	---	---	---	---
	11/29/1967	Pu foils	---	---	---	1.0E-03	---

Source: Rogers. 1977

--- = No data | *MFP = Mixed-fission product* | *MAP = Mixed-activation product*

FP = Fission products | *OWREX = Omega West Reactor Experiment* | *PTC = Plasma thermocouple*

GETR = General Electric Test Reactor | *SS = Stainless steel* | *LAMPRE = Los Alamos Molten Plutonium Reactor Experiment*

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content: MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
5 (Cont.)	12/11/1967	H-3 waste	---	---	---	---	1.0E-01
6	10/25/1967	U-235 samples	---	---	---	---	---
	1/18/1967	U-235 samples	---	---	---	---	---
	2/8/1968	H-3 trap	---	---	---	---	3.0E+02
7	5/6/1968	OWREX waste	1.0E+01	---	---	---	---
	5/8/1968	PTC waste	1.1E-02	---	---	---	---
	5/8/1968	PTC waste	9.0E+00	---	---	---	---
	5/8/1968	U-235, U-233, Pu-239, and Cf-252 sources	7.0E-02	---	---	3.0E-02	---
	5/23/1968	H-3 contaminated pump	---	---	---	---	5.2E+03
	7/15/1968	Fuel pins	---	---	---	---	---
	7/23/1968	Pu-238 foils	---	---	---	2.3E-03	---
8	7/1/1968	End boxes	---	1.0E+00	---	---	---
	8/13/1968	End boxes	---	1.0E+00	---	---	---
	9/12/1968	End boxes	---	1.0E+00	---	---	---
	11/25/1968	Th waste	---	---	---	---	---
9	12/31/1968	Irradiated Al and graphite	---	5.0E+00	---	---	---

Source: Rogers, 1977

--- = No data
MFP = Mixed-fission product
MAP = Mixed-activation product
FP = Fission products
OWREX = Omega West Reactor Experiment
PTC = Plasma thermocouple
GETR = General Electric Test Reactor
SS = Stainless steel
LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
9 (Cont.)	1/28/1969	Co-60, Cs-134, Cs-137, Eu-152, Pa-231, Zn-65, Pu-239, Pu-240, Pu-241, U-233, U-235, U-238 sources	6.1E-01	---	---	---	---
	---	Pu-239	---	---	---	8.3E-03	---
	---	Pu-240	---	---	---	5.8E-04	---
	---	Pu-241	---	---	---	2.0E-06	---
	---	U-233	---	---	---	---	---
	---	U-235	---	---	---	---	---
	---	U-236	---	---	---	---	---
10	3/27/1969	U-235 waste	---	---	---	---	---
	4/11/1969	Pu-239 cell waste	1.0E+00	---	---	---	---
	4/16/1969	U-235 contaminated chemicals	---	---	---	---	---
	5/20/1969	Pu-contaminated Ag	---	---	---	---	---
	---	Ag	---	---	---	---	---
	---	Ag 82%	---	---	---	---	---
	---	Ag 71.9%	---	---	---	---	---
11	4/21/1969	Pu, U sample vials	---	---	---	2.0E+00	---

Source: Rogers, 1977

--- = No data
FP = Fission products
GETR = General Electric Test Reactor
MFP = Mixed-fission product
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PTC = Plasma thermocouple
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[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
11 (Cont.)	5/1/1969	Irradiated U-235 sample	---	---	---	---	---
	6/25/1969	U-235 residues	---	---	---	---	---
	7/1/1969	End boxes	---	1.0E+00	---	---	---
	7/2/1969	Rover waste	1.0E+00	---	---	---	---
	8/15/1969	Sample holders	---	1.0E+00	---	---	---
12	5/16/1969	U-235 residues	---	---	---	---	---
	6/16/1969	Pu cell waste	3.0E+01	---	---	---	---
	7/2/1969	Rover waste	1.0E+00	---	---	---	---
	8/20/1969	U-235 residues	---	---	---	---	---
	9/16/1967	Al sample holders	---	5.0E+00	---	---	---
	9/24/1969	H-3 waste	---	---	---	---	5.0E+00
	10/8/1969	H-3 containers	---	---	---	---	9.5E+00
	10/8/1969	H-3 cylinder	---	---	---	---	4.5E+00
	11/4/1969	Cm-243, Cm-244, Am-243	---	---	---	---	---
	---	Am-243	---	---	---	1.0E-01	---
	1/15/1970	End boxes	---	1.0E+00	---	---	---
	2/20/1970	Pu lab waste	---	---	---	1.0E-03	---

Source: Rogers, 1977

--- = No data
FP = Fission products
GETR = General Electric Test Reactor
MFP = Mixed-fission product
OWREX = Omega West Reactor Experiment
SS = Stainless steel
MAP = Mixed-activation product
PTC = Plasma thermocouple
LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
12 (Cont.)	2/26/1970	Lab waste	---	---	---	1.0E-02	---
	3/4/1970	Pu-240	---	---	---	1.5E-01	---
13	8/29/1969	Pu, H-3 contamination, U-235	---	---	---	---	---
	10/10/1969	U-235 residues	---	---	---	---	---
	1/20/1970	Pu-239 contaminated waste	3.1E-01	---	---	---	---
	1/20/1970	Irradiated SS	---	5.5E-01	---	---	---
	1/22/1970	Irradiated concrete and iron	---	3.0E-01	---	---	---
	1/22/1970	U-235 metallographic samples	2.0E+00	---	---	---	---
	1/26/1970	Pu-238 waste	---	---	---	2.5E-02	---
	1/27/1970	U-235 cell waste	---	---	---	---	---
	1/29/1970	Hot cell waste	2.0E+00	---	---	---	---
	1/30/1970	Pu-239 contaminated waste	2.8E+00	---	---	---	---
	2/2/1970	Pu-239 contaminated waste	---	---	---	7.0E+00	---
	~~2/2/1970~~	~~Irradiated U-235 fuel~~	---	---	---	---	---
	2/4/1970	End boxes	---	3.0E-01		---	---
	2/4/1970	Hot cell waste	5.7E+00	---	---	3.0E+00	---
	2/13/1970	Pu-contaminated waste	1.0E-02	---	---	---	---

Source: Rogers, 1977

--- = No data

MFP = Mixed-fission product

MAP = Mixed-activation product

FP = Fission products

OWREX = Omega West Reactor Experiment

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[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
13 (Cont.)	3/3/1970	Pu-239 contaminated trash	1.2E+01	---	---	---	---
	3/3/1970	Ra source	---	---	---	---	---
	3/5/1970	End boxes	---	1.0E-01	---	---	---
	3/9/1970	Metallographic samples	3.5E+00	---	---	4.0E+00	---
	3/18/1970	D-38 with H-3	---	---	---	---	8.7E-04
	3/18/1970	Hot cell waste	5.0E+00	---	---	---	---
	3/18/1970	Hot cell waste	8.0E+00	---	---	---	---
	3/19/1970	Hot cell waste	1.0E+00	---	---	---	---
	3/19/1970	Hot cell waste	3.0E+00	---	---	---	---
	5/7/1970	Co-60 source	---	---	2.2E+00	---	---
14	5/8/1968	Neut. acids and NaOH	5.3E-01	---	---	---	---
	5/8/1968	Neut. acids and NaOH	5.4E+00	---	---	---	---
	5/14/1968	U-235 solution in vermiculite	---	---	---	---	---
	11/13/1968	U-235 solution in vermiculite	---	---	---	---	---
	8/6/1969	U-235 precipitate in vermiculite	---	---	---	---	---
	9/10/1969	Neut. solution HCL and U-235	---	---	---	---	---
15	11/25/1969	H-3 in H3PO4	---	---	---	---	1.8E+04

Source: Rogers. 1977

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MFP = Mixed-fission product
MAP = Mixed-activation product
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[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
15 (Cont.)	6/16/1970	Hot cell waste	4.0E+00	---	---	---	---
16	11/25/1969	H-3	---	---	---	---	1.8E+04
17	3/30/1970	H-3 pump	---	---	---	---	2.0E+04
	7/9/1970	Neut. acids	---	---	---	---	---
	7/10/1970	U-235 neut. acids	---	---	---	---	---
	8/13/1970	Ra-226 contaminated Pt	---	---	---	---	---
	9/28/1970	U-235 in Na	1.2E-01	---	---	---	---
	9/29/1970	U-235 in Na	4.0E+02	---	---	---	---
18	7/13/1970	Neut. Na	2.2E+01	---	---	---	---
	10/26/1970	Neut. Na	1.0E-01	---	---	---	---
	11/25/1970	Neut. Na	---	3.0E+01	---	---	---
24	9/3/1969	U-235 (52%)	---	---	---	---	---
	6/23/1970	Irradiated thermocouple	---	2.0E+00	---	---	---
	6/23/1970	U-235 residues	1.0E-01	---	---	---	---
	10/14/1970	End boxes	---	4.0E-01	---	---	---
	10/16/1970	Pu-contaminated metal	6.7E-02	---	---	---	---
25	9/29/1969	D-38 and U-235 (3%)	---	---	---	---	---

Source: Rogers, 1977

--- = No data
FP = Fission products
GETR = General Electric Test Reactor
MFP = Mixed-fission product
OWREX = Omega West Reactor Experiment
SS = Stainless steel
MAP = Mixed-activation product
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LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
25 (Cont.)	12/8/1969	Pu-238 contaminated Pt	---	---	---	---	---
	1/6/1970	U-233 foil	---	---	---	---	---
	3/23/1970	Irradiated SS tube	---	5.0E+00	---	---	---
	3/25/1970	End boxes	---	2.4E-01	---	---	---
	4/1/1970	Fuel elements, U-235 and FP	1.0E+00	---	---	---	---
	4/1/1970	Fuel elements, U-235 and FP	2.5E+00	---	---	---	---
	4/6/1970	U-235 residues	---	---	---	---	---
	4/7/1970	Hot cell waste	3.5E+01	---	---	---	---
	6/10/1970	U residue	---	---	---	---	---
	6/23/1970	U-235 residues	1.0E-01	---	---	---	---
	11/25/1970	End boxes	---	4.5E-01	---	---	---
26	12/10/1969	U-235 fuel element chips	1.0E+00	---	---	---	---
	4/15/1970	U-235 and D-38	---	---	---	---	---
	4/29/1970	Na, Cs-137, Pu contaminated pipe	1.0E-02	---	---	---	---
	5/1/1970	Cs-137, Sr-90 sources and rat bones	1.0E-03	---	---	---	---
	5/4/1970	Hot cell waste	1.0E+00	---	---	---	---

Source: Rogers. 1977

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FP = Fission products
GETR = General Electric Test Reactor
MFP = Mixed-fission product
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MAP = Mixed-activation product
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LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
26 (Cont.)	5/5/1970	Hot cell waste	1.5E-02	---	---	---	---
	5/6/1970	U-235 hot cell trash	5.0E-01	---	---	---	---
	6/12/1970	U-235 and Pu-242	1.2E-01	---	---	3.0E-02	---
	5/20/1970	Old sources	---	---	---	---	---
	6/2/1970	Sr-90 waste	1.0E-01	---	---	---	---
	6/23/1970	U-235 residues	---	---	---	---	---
	5/6/1970	Irradiated metal	1.0E-02	---	---	---	---
27	5/22/1970	U-235, Pu-239 reactor fuel	5.0E+00	---	---	3.4E+00	---
	5/22/1970	U, Pu, Co, Ce lab waste	2.0E-01	---	---	1.1E+01	---
	5/22/1970	Pu-239 hot cell waste	3.2E+01	---	---	---	---
	5/25/1970	Pu-239, U-235 hot cell waste	2.2E+01	---	---	5.8E+01	---
	5/27/1970	Pu-239 and FP	7.0E-01	---	---	1.0E+00	---
	6/1/1970	Manipulator booties	1.0E-01	---	---		---
	~~6/4/1970~~	~~Hot cell waste~~	~~3.5E+01~~	~~---~~	---	~~2.1E+01~~	---
	8/25/1970	End boxes		2.0E-01	---	---	---
28	6/23/1970	Hot cell waste	6.5E+01	---	---	---	---
	6/25/1970	Hot cell waste	7.9E+01	---	---	---	---

Source: Rogers, 1977

--- = No data

MFP = Mixed-fission product

MAP = Mixed-activation product

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GETR = General Electric Test Reactor

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[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content				
			MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
28 (Cont.)	7/1/1970	Irradiated sample holders	---	1.4E+01	---	---	---
	7/13/1970	GETR hardware	1.2E+02	---	---	---	---
	7/17/1970	U-235 residues	---	---	---	---	---
29	7/9/1970	Thermocouple waste	1.9E+01	---	---	---	---
	7/15/1970	U-235 thermocouple waste	2.5E+00	---	---	---	---
	7/22/1970	Pu-239 residue	2.0E-03	---	---	---	---
	7/29/1970	U-235 residues		---	---	---	---
	7/29/1970	U-235 cell filter (charcoal)	1.5E+00	---	---	---	---
	7/29/1970	U-235 hot cell waste	2.0E+00	---	---	---	---
30	7/28/1970	Pu-239 hot cell waste	4.1E+01	---	---	---	---
	8/24/1970	Irradiated SS pipe	---	1.0E-01	---	---	---
	9/8/1970	Pu-239 hot cell waste	2.0E+00	---	---	---	---
	9/8/1970	Pu-239 hot cell waste	4.5E+00	---	---	---	---
	9/15/1970	Pu-239 hot cell waste	2.4E+01	---	---	5.0E+00	---
	9/16/1970	Pu-239 hot cell waste	3.3E-01	---	---	5.3E-01	---
	10/13/1970	Irradiated Al	4.0E-01	---	---	---	---
	2/26/1970	End boxes	4.0E-01	---	---	---	---
31	9/24/1970	U-235 residues	---	---	---	---	---

Source: Rogers, 1977

--- = No data
MFP = Mixed-fission product
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FP = Fission products
OWREX = Omega West Reactor Experiment
PTC = Plasma thermocouple
GETR = General Electric Test Reactor
SS = Stainless steel
LAMPRE = Los Alamos Molten Plutonium Reactor Experiment

[a] *The table includes only those disposal records for which there were estimates of radionuclide mass or activity.*

Table II-1 (Continued)
Pre-1971 Shaft Disposal Records [a]

Shaft No.	Disposal Date	Waste Description	Radionuclide Content: MFP (Ci)	MAP (Ci)	Transuranics (g)	Tritium (Ci)	Uranium (g)
31 (Cont.)	10/1/1970	U-235 and U-238 residue	---	---	---	---	---
	11/13/1970	U-235 residue and D-38	---	---	---	---	---
32	5/27/1970	LAMPRE-II lines and valves	---	---	---	1.0E-01	---
33	10/23/1970	Pu-239 hot cell waste	5.0E+00	---	---	---	---
	10/26/1970	Pu-239 hot cell waste	9.0E-01	---	---	---	---
	10/26/1970	Pu-239 hot cell waste	2.8E+00	---	---	---	---
	10/26/1970	Pu-239 metallographic samples	3.1E+01	---	---	2.5E+01	---
	10/28/1970	Pu-239 hot cell waste	2.2E+00	---	---	---	---
	10/30/1970	Pu-239 hot cell waste	1.3E+00	---	---	---	---
	11/2/1970	Pu-239 hot cell waste	4.0E+00	---	---	4.5E+01	---
	11/17/1970	Pu-238 lab waste	5.8E-02	---	---		---
	---	Pu-238	---	---	---	3.0E-01	---
	12/10/1970	Hot cell waste	1.3E+01	---	---	---	---
	12/10/1970	Pu-239 hot cell waste	5.0E+00	---	---	---	---
39	11/30/1970	Be and steel	---	2.0E-03	---	---	---
	12/28/1970	H-3 waste	---	---	---	---	5.7E+02

Source: Rogers, 1977

--- = No data

FP = Fission products

GETR = General Electric Test Reactor

MFP = Mixed-fission product

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SS = Stainless steel

MAP = Mixed-activation product

PTC = Plasma thermocouple

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[a] The table includes only those disposal records for which there were estimates of radionuclide mass or activity.

Table II-2
Pre-1971 Shaft Waste Volumes

Shaft No.	Shaft Dimensions (diameter, depth in m)	Waste Volume (m^3)
1	6.1E-01, 7.6E+00	1.8E+00
2	6.1E-01, 7.6E+00	1.2E+00
3	6.1E-01, 7.6E+00	1.1E+00
4	6.1E-01, 7.6E+00	1.3E+00
5	6.1E-01, 7.6E+00	8.4E-01
6	6.1E-01, 7.6E+00	5.8E-01
7	6.1E-01, 7.6E+00	1.6E+00
8	6.1E-01, 7.6E+00	3.0E+00
9	6.1E-01, 7.6E+00	2.0E+00
10	6.1E-01, 7.6E+00	1.5E+00
11	9.1E-01, 7.6E+00	2.0E+00
12	9.1E-01, 7.6E+00	2.3E+00
13	9.1E-01, 7.6E+00	3.4E+00
14	3.0E-01, 7.6E+00	7.6E-01
15	3.0E-01, 7.6E+00	1.4E-01
16	3.0E-01, 7.6E+00	1.1E-01
17	3.0E-01, 7.6E+00	1.5E-01
18	3.0E-01, 7.6E+00	1.5E-01
24	3.0E-01, 7.6E+00	1.2E+00
25	6.1E-01, 7.6E+00	9.6E-01
26	6.1E-01, 7.6E+00	1.6E+00
27	6.1E-01, 7.6E+00	3.6E-01
28	6.1E-01, 7.6E+00	8.4E-01
29	6.1E-01, 7.6E+00	6.7E-01
30	6.1E-01, 7.6E+00	2.4E-01
31	6.1E-01, 7.6E+00	5.4E-01
32	6.1E-01, 7.6E+00	2.8E-01
33	6.1E-01, 7.6E+00	2.7E-01
34	1.8E+00, 1.8E+01	1.1E+01
36	9.1E-01, 1.2E+01	1.8E+00
37	9.1E-01, 1.2E+01	1.8E+00
38	9.1E-01, 1.2E+01	1.8E+00
39	1.8E+00, 1.8E+01	9.3E-01

Source: Rogers, 1977

References

Rogers, M.A., 1977, *History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)*, Los Alamos Scientific Laboratory Report LA-6848-MN, Vol. 1, June.

Attachment III
Methodology for Estimating Radionuclide-Specific Activities for Mixed Fission and Mixed Activation Product Waste

III.1 Introduction

A portion of the waste included in the low-level waste (LLW) disposal database and the transuranic (TRU) waste database at Los Alamos National Laboratory (LANL or the Laboratory) is referred to as mixed-fission products (MFP) and mixed-activation products (MAP). The radionuclide-specific activities associated with these materials were estimated as part of the inventory characterization effort. The methods used to develop these activities for the MFP waste are described below, followed by a discussion of the approach used to estimate isotope-specific activities for the MAP waste.

III.2 Mixed-Fission Product Waste

Approximately 12×10^4 Ci of MFP waste were disposed of at Material Disposal Area (MDA) G from 1971 through the mid-1990s. The major generators of this waste were Technical Areas (TAs) 2, 3, 21, and 48; the volumes and activities of waste generated by these facilities are summarized in Table III-1. On an activity basis, TA-3 accounts for 89 percent of the MFP waste that has been disposed of at MDA G; TA-2, TA-21, and TA-48 account for 2 to 6 percent of the total. Approximately 60 percent of the total activity associated with the MFP waste was associated with TRU waste.

Table III-1 Mixed-Fission Waste Characteristics, by Waste Generator

Technical Area Generating MFP Wastes	Waste Volume (m^3)	Waste Activity (Ci)
2	3.2E+02	3.3E+02
3	3.0E+03	1.0E+04
21	4.1E+03	2.5E+02
48	3.1E+03	6.6E+02

The radionuclides present in MFP waste depend on the fissionable materials that led to the generation of the waste. An examination of the LLW and TRU waste data indicated that Pu-239 and U-235, both of which are fissile materials, were frequently associated with the MFP waste. Of the 771 packages of TRU waste that contained MFP, Pu-239 occurred in 62 percent and U-235 in 41 percent. An examination of the MFP waste included in the LLW disposal database shows that Pu-239 occurred in about 7 percent of the packages while U-235 occurred in 1 percent.

Based on the evaluation of the waste records, it was assumed that the MFP waste was generated by neutron interactions with Pu-239 and U-235. England and Rider (1994) have compiled fission-product yields for approximately 35 radionuclides and several neutron energies. The fission-yield data compiled for U-235 and Pu-239 were adopted for use in this MFP waste allocation analysis. Yields for thermal, fast, and high-energy neutrons were available for these isotopes; data for thermal and fast neutrons were used to estimate the radionuclide abundances in the MFP waste.

The fission-yield data taken from England and Rider (1994) are provided in Table III-2. This table lists the radionuclides generated by U-235 and Pu-239 fission for thermal and fast neutrons, the fission products' half-lives, and the corresponding yields. The listed yields represent the abundance of each radionuclide per 100 fissions of the listed radionuclide and neutron energy. The fission yields may be expressed in terms of activity by multiplying the data by the decay constants of the various radionuclides. Normalizing these activities by the total MFP activity yields radionuclide-specific activity fractions that may be used to allocate the listed MFP activities to specific isotopes. These calculations are included in the table.

The yields and activity fractions shown in Table III-2 correspond to the time at which fission occurs. Given the very short half-lives of most of the fission products, the radionuclide abundances in the waste will change significantly as the age of the waste increases and radioactive decay occurs. The effects that the age of the waste has on radionuclide abundances are shown in Table III-3; this table lists radionuclide activity fractions for radionuclides in MFP waste with ages of 1, 2, 5, and 10 years. For simplicity, all radionuclides with activity fractions less than 1.0×10^{-6} have been excluded from the table. Approximately 400 radionuclides have activity fractions equal to or greater than 1.0×10^{-6} at the time of fission. This number drops to 24 radionuclides at the end of the first year after waste generation; only 11 radionuclides have activity fractions of 1.0×10^{-6} or more 10 years after the MFP waste is generated.

An accurate assessment of radionuclide abundances in the MFP waste depends on the nature of the fission events that led to the generation of the material and the amount of time that has elapsed since the fission events that were responsible for the generation of the material. The nature of the fission events will depend upon the relative abundance of Pu-239 and U-235 in the feed material and the distribution of neutron energies to which these fissile materials are exposed. Historical reviews of reactor operations at the Laboratory (e.g., Bunker, 1983; Widner et al., 2004) indicate that most reactors in operation during the time MDA G accepted MFP waste were fueled by enriched uranium; this suggests the majority of the fission products were the result of neutron interactions with U-235. Nevertheless, the presence of plutonium fission products is also expected because one reactor in operation during the period of interest accepted molten plutonium as fuel. Furthermore, plutonium fission products occur in waste from uranium-based reactors as a result of interactions between fast neutrons and U-238. These plutonium fissions may represent a significant proportion of the total fission events; they account for one-third or more of the total fission events during the latter stages of commercial reactor operations.

Table III-2
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Cr-66	4.8E-15	2.4E-12	4.0E-11	0.0E+00	8.9E-12	5.8E-08	5.2E-06	0.0E+00	1.9E-06
Mn-66	2.1E-09	7.2E-10	9.4E-09	3.7E-10	4.0E-09	3.9E-11	2.7E-09	1.7E-10	1.9E-09
Fe-66	1.4E-06	3.8E-08	4.0E-07	3.6E-08	2.4E-07	3.1E-12	1.7E-10	2.5E-11	1.7E-10
Co-66	6.0E-09	2.8E-08	2.7E-07	1.2E-07	4.6E-07	5.4E-10	2.7E-08	1.8E-08	7.5E-08
Ni-66	6.2E-03	5.8E-09	5.0E-08	6.8E-08	1.7E-07	1.1E-16	4.9E-15	1.0E-14	2.7E-14
Cu-66	9.7E-06	1.4E-11	1.1E-10	1.4E-09	2.1E-09	1.7E-16	7.2E-15	1.4E-13	2.1E-13
Zn-66	NA	0.0E+00	0.0E+00	3.5E-12	3.1E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cr-67	---	0.0E+00	4.9E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Mn-67	1.3E-09	5.4E-10	5.3E-09	7.6E-11	1.6E-09	4.6E-11	2.5E-09	5.4E-11	1.2E-09
Fe-67	1.5E-08	6.9E-08	5.1E-07	1.8E-08	2.3E-07	5.2E-10	2.1E-08	1.1E-09	1.5E-08
Co-67	1.4E-08	2.0E-07	1.3E-06	1.9E-07	1.4E-06	1.7E-09	5.9E-08	1.3E-08	1.0E-07
Ni-67	6.7E-07	9.0E-08	5.0E-07	2.3E-07	1.2E-06	1.6E-11	4.6E-10	3.3E-10	1.7E-09
Cu-67	7.1E-03	9.7E-10	5.1E-09	1.6E-08	4.8E-08	1.6E-17	4.4E-16	2.1E-15	6.7E-15
Zn-67	NA	0.0E+00	4.5E-12	9.9E-11	1.9E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Mn-68	8.9E-10	6.7E-11	6.7E-10	1.6E-11	3.1E-10	8.6E-12	4.6E-10	1.7E-11	3.5E-10
Fe-68	4.1E-09	3.9E-08	2.9E-07	1.4E-08	1.6E-07	1.1E-09	4.3E-08	3.1E-09	3.9E-08
Co-68	4.1E-08	2.5E-07	1.5E-06	3.1E-07	2.2E-06	6.9E-10	2.3E-08	7.2E-09	5.4E-08

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ni-68	9.2E-07	4.2E-07	2.2E-06	1.1E-06	5.5E-06	5.2E-11	1.5E-09	1.2E-09	6.0E-09
Cu-68m	7.2E-06	7.4E-09	3.7E-08	1.2E-07	3.8E-07	1.2E-13	3.2E-12	1.5E-11	5.2E-11
Cu-68	9.8E-07	3.2E-09	1.4E-08	5.0E-08	1.4E-07	3.7E-13	8.6E-12	4.8E-11	1.4E-10
Zn-68	NA	4.7E-11	2.1E-10	3.7E-09	7.3E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ga-68	1.3E-04	0.0E+00	0.0E+00	2.0E-12	2.4E-12	0.0E+00	0.0E+00	1.5E-17	1.9E-17
Mn-69	4.4E-10	8.0E-12	8.9E-11	2.7E-12	6.3E-11	2.1E-12	1.2E-10	5.8E-12	1.4E-10
Fe-69	5.4E-09	1.2E-08	9.6E-08	5.9E-09	8.5E-08	2.6E-10	1.1E-08	1.0E-09	1.6E-08
Co-69	7.0E-09	3.3E-07	2.1E-06	4.7E-07	3.9E-06	5.3E-09	1.8E-07	6.4E-08	5.6E-07
Ni-69	3.6E-07	1.1E-06	6.0E-06	3.7E-06	2.1E-05	3.6E-10	1.0E-08	9.7E-09	5.8E-08
Cu-69	5.4E-06	1.1E-07	5.6E-07	1.7E-06	6.0E-06	2.4E-12	6.3E-11	2.9E-10	1.1E-09
Zn-69m	1.6E-03	1.1E-09	4.8E-09	7.0E-08	1.7E-07	7.7E-17	1.9E-15	4.3E-14	1.1E-13
Zn-69	1.1E-04	2.5E-10	9.8E-10	1.6E-08	3.5E-08	2.7E-16	5.7E-15	1.5E-13	3.3E-13
Ga-69	NA	0.0E+00	1.1E-12	1.8E-10	2.5E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Mn-70	---	0.0E+00	5.8E-12	0.0E+00	5.3E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Fe-70	4.8E-15	3.2E-09	2.8E-08	1.8E-09	2.6E-08	7.8E-05	3.6E-03	3.7E-04	5.5E-03
Co-70	4.1E-09	2.1E-07	1.4E-06	3.6E-07	3.0E-06	5.8E-09	2.1E-07	8.4E-08	7.3E-07
Ni-70	1.9E-07	2.8E-06	1.5E-05	9.3E-06	5.0E-05	1.7E-09	4.7E-08	4.7E-08	2.6E-07
Cu-70m	1.5E-06	4.5E-07	2.2E-06	6.6E-06	2.4E-05	3.4E-11	8.9E-10	4.2E-09	1.6E-08
Cu-70	1.6E-07	1.5E-07	6.1E-07	2.2E-06	6.7E-06	1.1E-10	2.3E-09	1.3E-08	4.2E-08

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Zn-70	NA	3.0E-08	1.2E-07	1.5E-06	3.5E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ga-70	4.0E-05	1.5E-11	5.7E-11	7.8E-09	1.1E-08	4.2E-17	8.6E-16	1.8E-13	2.7E-13
Fe-71	4.8E-15	4.9E-10	5.2E-09	1.8E-10	3.9E-09	1.2E-05	6.7E-04	3.7E-05	8.0E-04
Co-71	6.7E-09	1.5E-07	1.1E-06	1.3E-07	1.6E-06	2.6E-09	1.1E-07	1.9E-08	2.4E-07
Ni-71	8.1E-08	4.4E-06	2.6E-05	7.5E-06	6.1E-05	6.1E-09	1.9E-07	8.8E-08	7.5E-07
Cu-71	6.3E-07	3.5E-06	1.8E-05	2.1E-05	1.1E-04	6.3E-10	1.7E-08	3.2E-08	1.7E-07
Zn-71m	4.5E-04	3.3E-07	1.5E-06	6.2E-06	2.4E-05	8.3E-14	2.0E-12	1.3E-11	5.2E-11
Zn-71	4.6E-06	7.7E-08	3.0E-07	1.5E-06	4.8E-06	1.9E-12	4.1E-11	3.1E-10	1.0E-09
Ga-71	NA	9.4E-10	3.8E-09	1.4E-07	3.1E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ge-71m	3.1E-02	0.0E+00	0.0E+00	1.0E-10	1.5E-10	0.0E+00	0.0E+00	3.1E-18	4.8E-18
Fe-72	4.8E-15	7.2E-11	1.1E-09	2.3E-11	4.6E-10	1.7E-06	1.4E-04	4.6E-06	9.5E-05
Co-72	2.9E-09	5.8E-08	6.0E-07	4.1E-08	4.9E-07	2.3E-09	1.3E-07	1.4E-08	1.7E-07
Ni-72	5.1E-08	7.6E-06	5.6E-05	8.5E-06	6.4E-05	1.7E-08	6.8E-07	1.6E-07	1.3E-06
Cu-72	2.1E-07	1.3E-05	7.8E-05	5.2E-05	2.5E-04	7.0E-09	2.3E-07	2.4E-07	1.2E-06
Zn-72	5.3E-03	6.1E-06	3.1E-05	5.8E-05	2.0E-04	1.3E-13	3.5E-12	1.0E-11	3.7E-11
Ga-72	1.6E-03	3.9E-08	1.6E-07	2.4E-06	5.2E-06	2.8E-15	6.2E-14	1.4E-12	3.2E-12
Ge-72	NA	3.6E-11	1.4E-10	1.3E-08	1.8E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
As-72	3.0E-03	0.0E+00	0.0E+00	1.7E-12	1.5E-12	0.0E+00	0.0E+00	5.3E-19	4.9E-19
Fe-73	---	5.5E-12	8.3E-11	0.0E+00	1.5E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Co-73	4.1E-09	2.2E-08	2.2E-07	6.8E-09	6.0E-08	6.2E-10	3.3E-08	1.6E-09	1.4E-08
Ni-73	1.9E-08	7.1E-06	5.0E-05	3.5E-06	2.0E-05	4.3E-08	1.6E-06	1.8E-07	1.0E-06
Cu-73	1.3E-07	4.7E-05	2.6E-04	7.1E-05	2.5E-04	4.1E-08	1.2E-06	5.1E-07	1.8E-06
Zn-73	7.6E-07	4.6E-05	2.1E-04	1.7E-04	4.1E-04	7.0E-09	1.7E-07	2.1E-07	5.3E-07
Ga-73	5.6E-04	1.2E-06	4.8E-06	2.2E-05	3.5E-05	2.5E-13	5.3E-12	3.8E-11	6.2E-11
Ge-73m	1.7E-08	5.6E-10	1.7E-09	5.6E-08	5.3E-08	3.8E-12	6.4E-11	3.2E-09	3.1E-09
Ge-73	NA	2.4E-09	8.5E-09	2.4E-07	2.6E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
As-73	2.2E-01	0.0E+00	0.0E+00	1.4E-10	9.1E-11	0.0E+00	0.0E+00	6.2E-19	4.1E-19
Fe-74	---	0.0E+00	3.5E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Co-74	2.9E-09	3.0E-09	2.4E-08	7.3E-10	7.2E-09	1.2E-10	5.1E-09	2.4E-10	2.4E-09
Ni-74	2.2E-08	4.6E-06	2.5E-05	1.4E-06	8.5E-06	2.4E-08	6.9E-07	5.8E-08	3.8E-07
Cu-74	5.1E-08	6.8E-05	2.9E-04	6.3E-05	2.5E-04	1.5E-07	3.5E-06	1.2E-06	4.9E-06
Zn-74	3.0E-06	2.5E-04	8.4E-04	4.4E-04	1.2E-03	9.5E-09	1.7E-07	1.4E-07	4.0E-07
Ga-74	1.5E-05	1.5E-05	4.2E-05	1.2E-04	2.3E-04	1.1E-10	1.7E-09	7.7E-09	1.5E-08
Ge-74	NA	1.7E-07	4.2E-07	5.6E-06	7.2E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
As-74m	2.5E-07	1.2E-11	3.0E-11	4.7E-09	4.1E-09	5.2E-15	7.2E-14	1.8E-11	1.6E-11
As-74	4.9E-02	5.0E-12	1.1E-11	2.0E-09	1.5E-09	1.2E-20	1.4E-19	4.0E-17	3.1E-17
Co-75	2.6E-09	3.8E-10	3.4E-09	5.5E-11	4.0E-10	1.7E-11	8.1E-10	2.0E-11	1.5E-10
Ni-75	1.9E-08	1.5E-06	8.9E-06	2.6E-07	1.3E-06	9.2E-09	2.9E-07	1.3E-08	6.6E-08

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Cu-75	3.9E-08	1.0E-04	4.4E-04	4.4E-05	1.3E-04	3.0E-07	6.9E-06	1.1E-06	3.4E-06
Zn-75	3.2E-07	7.7E-04	2.6E-03	6.8E-04	1.5E-03	2.7E-07	4.9E-06	2.0E-06	4.6E-06
Ga-75	4.0E-06	1.9E-04	5.0E-04	5.8E-04	8.6E-04	5.5E-09	7.7E-08	1.4E-07	2.1E-07
Ge-75m	1.5E-06	4.6E-06	1.1E-05	5.3E-05	5.7E-05	3.4E-10	4.2E-09	3.3E-08	3.7E-08
Ge-75	1.6E-04	6.8E-07	1.4E-06	7.9E-06	7.8E-06	5.0E-13	5.6E-12	4.8E-11	4.9E-11
As-75	NA	2.6E-09	5.5E-09	2.7E-07	1.9E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Se-75	3.3E-01	0.0E+00	0.0E+00	9.1E-11	4.5E-11	0.0E+00	0.0E+00	2.6E-19	1.3E-19
Co-76	---	2.5E-11	3.5E-10	2.2E-12	2.0E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ni-76	6.3E-09	5.0E-07	4.4E-06	3.9E-08	2.4E-07	9.1E-09	4.2E-07	5.9E-09	3.7E-08
Cu-76	2.0E-08	8.3E-05	5.2E-04	1.7E-05	6.3E-05	4.7E-07	1.6E-05	7.8E-07	3.1E-06
Zn-76	1.8E-07	1.8E-03	1.2E-02	8.6E-04	2.3E-03	1.2E-06	4.1E-05	4.6E-06	1.2E-05
Ga-76	9.2E-07	1.1E-03	4.7E-03	1.5E-03	2.8E-03	1.3E-07	3.1E-06	1.6E-06	3.0E-06
Ge-76	NA	1.3E-04	4.7E-04	5.1E-04	6.7E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
As-76	3.0E-03	1.7E-07	5.5E-07	5.5E-06	4.8E-06	6.3E-15	1.1E-13	1.8E-12	1.6E-12
Se-76	NA	3.0E-11	9.4E-11	7.1E-09	4.3E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ni-77	3.3E-09	5.6E-08	4.1E-07	3.5E-09	2.1E-08	2.0E-09	7.7E-08	1.0E-09	6.3E-09
Cu-77	1.5E-08	4.5E-05	2.2E-04	5.4E-06	2.1E-05	3.4E-07	9.2E-06	3.5E-07	1.4E-06
Zn-77	6.7E-08	3.1E-03	1.2E-02	6.8E-04	1.8E-03	5.4E-06	1.1E-04	9.7E-06	2.7E-05
Ga-77	4.1E-07	4.1E-03	1.7E-02	3.8E-03	7.0E-03	1.1E-06	2.5E-05	8.8E-06	1.7E-05

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ge-77m	1.7E-06	8.9E-05	4.3E-04	3.5E-04	4.5E-04	6.1E-09	1.6E-07	2.0E-07	2.7E-07
Ge-77	1.3E-03	6.0E-04	3.2E-03	2.3E-03	3.3E-03	5.3E-11	1.5E-09	1.7E-09	2.5E-09
As-77	4.4E-03	4.3E-06	1.9E-05	9.9E-05	9.4E-05	1.1E-13	2.6E-12	2.1E-11	2.1E-11
Se-77m	5.5E-07	1.8E-09	7.5E-09	2.6E-07	2.2E-07	3.8E-13	8.3E-12	4.5E-10	4.0E-10
Se-77	NA	2.8E-10	1.0E-09	3.9E-08	3.0E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ni-78	4.2E-09	5.0E-09	2.6E-08	2.4E-10	1.2E-09	1.4E-10	3.8E-09	5.4E-11	2.8E-10
Cu-78	1.1E-08	1.1E-05	3.8E-05	9.8E-07	3.1E-06	1.2E-07	2.1E-06	8.7E-08	2.8E-07
Zn-78	4.8E-08	3.6E-03	8.6E-03	4.4E-04	9.5E-04	8.6E-06	1.1E-04	8.9E-06	2.0E-05
Ga-78	1.6E-07	1.0E-02	2.6E-02	5.5E-03	8.2E-03	7.3E-06	9.9E-05	3.3E-05	5.0E-05
Ge-78	1.7E-04	6.9E-03	2.2E-02	1.2E-02	1.3E-02	4.8E-09	8.2E-08	6.8E-08	7.8E-08
As-78	1.7E-04	1.3E-04	2.9E-04	9.9E-04	7.7E-04	8.6E-11	1.0E-09	5.5E-09	4.4E-09
Se-78	NA	2.5E-07	6.2E-07	1.2E-05	6.5E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cu-79	6.0E-09	0.0E+00	4.7E-06	1.1E-07	4.9E-07	0.0E+00	4.8E-07	1.8E-08	8.1E-08
Zn-79	3.2E-08	1.6E-03	2.6E-03	1.3E-04	4.0E-04	5.9E-06	5.1E-05	3.9E-06	1.3E-05
Ga-79	9.0E-08	1.7E-02	3.2E-02	5.5E-03	1.2E-02	2.2E-05	2.2E-04	5.8E-05	1.3E-04
Ge-79	6.0E-07	2.3E-02	5.4E-02	3.0E-02	4.1E-02	4.4E-06	5.5E-05	4.7E-05	6.7E-05
As-79	1.7E-05	2.7E-03	2.9E-03	8.0E-03	7.7E-03	1.8E-08	1.0E-07	4.5E-07	4.4E-07
Se-79m	7.5E-06	1.7E-06	1.9E-06	3.0E-05	2.0E-05	2.5E-11	1.6E-10	3.8E-09	2.6E-09
Se-79	2.9E+05	1.1E-05	1.4E-05	2.0E-04	1.5E-04	4.4E-21	2.9E-20	6.6E-19	5.0E-19

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Br-79m	1.5E-07	1.0E-09	1.2E-09	1.9E-07	9.7E-08	7.7E-13	4.8E-12	1.2E-09	6.2E-10
Ni-80	---	1.6E-12	1.3E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cu-80	2.9E-09	5.3E-08	2.5E-07	7.2E-09	2.7E-08	2.1E-09	5.5E-08	2.4E-09	9.3E-09
Zn-80	1.7E-08	2.4E-04	7.1E-04	3.3E-05	8.0E-05	1.6E-06	2.5E-05	1.8E-06	4.6E-06
Ga-80	5.4E-08	1.2E-02	2.1E-02	3.6E-03	5.6E-03	2.5E-05	2.4E-04	6.4E-05	1.0E-04
Ge-80	9.4E-07	1.0E-01	1.4E-01	5.5E-02	6.0E-02	1.3E-05	9.0E-05	5.6E-05	6.4E-05
As-80	5.1E-07	1.4E-02	1.6E-02	3.2E-02	2.5E-02	3.1E-06	2.0E-05	6.0E-05	4.8E-05
Se-80	NA	4.9E-04	4.3E-04	3.3E-03	1.8E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Br-80m	5.0E-04	1.1E-07	9.0E-08	1.1E-06	2.6E-06	2.5E-14	1.1E-13	2.1E-12	5.2E-12
Cu-81	2.3E-09	0.0E+00	9.4E-09	2.8E-10	1.1E-09	0.0E+00	2.5E-09	1.1E-10	4.6E-10
Zn-81	9.2E-09	0.0E+00	7.2E-05	3.6E-06	8.9E-06	0.0E+00	4.8E-06	3.7E-07	9.6E-07
Ga-81	3.9E-08	8.2E-03	1.0E-02	1.5E-03	2.3E-03	2.4E-05	1.6E-04	3.7E-05	5.9E-05
Ge-81	2.4E-07	1.3E-01	1.5E-01	5.5E-02	5.7E-02	6.0E-05	3.7E-04	2.2E-04	2.4E-04
As-81	1.0E-06	6.1E-02	6.8E-02	1.0E-01	7.1E-02	6.7E-06	4.0E-05	9.4E-05	6.7E-05
Se-81m	1.1E-04	6.9E-03	3.9E-03	2.1E-02	1.1E-02	7.3E-09	2.2E-08	1.9E-07	9.6E-08
Se-81	3.5E-05	1.0E-03	5.3E-04	3.2E-03	1.4E-03	3.4E-09	9.2E-09	8.6E-08	4.0E-08
Br-81	NA	8.9E-06	5.9E-06	2.7E-04	8.3E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cu-82	---	1.5E-10	1.6E-10	3.4E-12	2.0E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zn-82	4.0E-09	1.1E-05	6.4E-06	1.8E-07	6.5E-07	3.1E-07	9.8E-07	4.2E-08	1.6E-07

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ga-82	1.9E-08	6.3E-03	2.4E-03	2.0E-04	4.6E-04	3.8E-05	7.7E-05	1.0E-05	2.4E-05
Ge-82	1.5E-07	1.3E-01	1.5E-01	2.7E-02	4.1E-02	9.9E-05	6.3E-04	1.8E-04	2.8E-04
As-82m	4.3E-07	2.7E-02	7.4E-02	5.7E-02	5.7E-02	7.2E-06	1.0E-04	1.3E-04	1.3E-04
As-82	6.0E-07	1.3E-01	7.4E-02	5.7E-02	5.7E-02	2.5E-05	7.5E-05	9.0E-05	9.4E-05
Se-82	NA	3.7E-02	4.0E-02	8.8E-02	6.2E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zn-83	2.7E-09	6.3E-08	2.5E-07	4.9E-09	2.2E-08	2.7E-09	5.7E-08	1.8E-09	8.3E-09
Ga-83	9.8E-09	1.9E-04	4.7E-04	2.3E-05	6.1E-05	2.2E-06	2.9E-05	2.2E-06	6.2E-06
Ge-83	6.0E-08	4.8E-02	7.7E-02	8.0E-03	1.4E-02	9.1E-05	7.8E-04	1.3E-04	2.4E-04
As-83	4.2E-07	2.9E-01	3.1E-01	1.2E-01	1.3E-01	7.9E-05	4.4E-04	2.6E-04	3.1E-04
Se-83m	2.2E-06	3.4E-02	3.2E-02	3.7E-02	2.7E-02	1.7E-06	8.8E-06	1.6E-05	1.2E-05
Se-83	4.2E-05	1.4E-01	1.6E-01	1.2E-01	1.3E-01	3.9E-07	2.3E-06	2.7E-06	3.1E-06
Br-83	2.7E-04	2.0E-02	3.2E-03	1.7E-02	1.0E-02	8.2E-09	7.1E-09	6.0E-08	3.6E-08
Kr-83m	2.1E-04	1.6E-06	8.5E-07	2.9E-05	1.1E-05	8.4E-13	2.5E-12	1.3E-10	5.1E-11
Zn-84	---	1.2E-06	7.2E-09	1.0E-10	5.8E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ga-84	2.9E-09	1.1E-02	3.8E-05	1.4E-06	4.5E-06	4.5E-04	8.3E-06	4.5E-07	1.6E-06
Ge-84	3.0E-08	1.9E-02	3.0E-02	1.9E-03	4.0E-03	7.2E-05	6.1E-04	5.8E-05	1.3E-04
As-84	1.3E-07	2.0E-01	2.8E-01	6.6E-02	9.0E-02	1.8E-04	1.3E-03	5.0E-04	7.0E-04
Se-84	6.1E-06	6.3E-01	5.9E-01	3.3E-01	3.3E-01	1.2E-05	6.0E-05	5.1E-05	5.4E-05
Br-84m	1.1E-05	1.7E-02	1.8E-02	4.9E-02	3.5E-02	1.7E-07	9.6E-07	4.1E-06	3.0E-06

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).
NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable
--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Br-84	6.1E-05	1.9E-02	8.4E-03	2.7E-02	1.6E-02	3.5E-08	8.6E-08	4.3E-07	2.7E-07
Ga-85	2.8E-09	5.9E-07	2.2E-06	2.9E-08	2.0E-07	2.4E-08	5.0E-07	9.9E-09	7.1E-08
Ge-85	1.7E-08	2.1E-03	4.9E-03	1.1E-04	5.0E-04	1.4E-05	1.8E-04	6.0E-06	2.9E-05
As-85	6.4E-08	1.2E-01	2.1E-01	1.4E-02	4.2E-02	2.2E-04	2.0E-03	2.1E-04	6.5E-04
Se-85m	6.0E-07	4.5E-01	5.3E-01	2.0E-01	1.9E-01	8.5E-05	5.4E-04	3.2E-04	3.1E-04
Se-85	1.0E-06	4.5E-01	5.3E-01	2.1E-01	1.9E-01	5.1E-05	3.2E-04	1.9E-04	1.9E-04
Br-85	5.5E-06	2.4E-01	1.8E-01	1.5E-01	1.9E-01	4.9E-06	2.1E-05	2.6E-05	3.5E-05
Kr-85m	5.1E-04	5.9E-03	6.3E-04	2.4E-03	1.9E-03	1.3E-09	7.6E-10	4.4E-09	3.8E-09
Kr-85	1.1E+01	2.6E-02	3.1E-03	1.0E-02	9.5E-03	2.7E-13	1.8E-13	8.9E-13	8.7E-13
Zn-86	---	2.3E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ga-86	4.8E-15	3.3E-05	4.9E-08	1.2E-09	4.4E-09	7.9E-01	6.3E-03	2.4E-04	9.3E-04
Ge-86	7.8E-09	6.3E-01	5.4E-04	1.8E-05	4.5E-05	9.2E-03	4.3E-05	2.1E-06	5.7E-06
As-86	2.9E-08	2.0E-02	5.9E-02	6.0E-03	1.1E-02	8.0E-05	1.3E-03	2.0E-04	3.7E-04
Se-86	4.8E-07	8.4E-01	1.2E+00	2.9E-01	3.3E-01	2.0E-04	1.6E-03	5.9E-04	6.8E-04
Br-86m	1.4E-07	2.3E-01	2.2E-01	1.9E-01	1.8E-01	1.8E-04	9.7E-04	1.3E-03	1.2E-03
Br-86	1.8E-06	2.3E-01	2.3E-01	1.9E-01	1.8E-01	1.5E-05	7.9E-05	1.0E-04	9.9E-05
Ge-87	4.2E-09	2.2E-03	3.2E-05	9.3E-07	2.6E-06	5.9E-05	4.6E-06	2.1E-07	6.0E-07
As-87	1.9E-08	5.1E-02	1.7E-02	1.3E-03	2.3E-03	3.0E-04	5.4E-04	6.4E-05	1.2E-04
Se-87	1.8E-07	7.3E-01	6.8E-01	1.4E-01	1.8E-01	4.6E-04	2.3E-03	7.1E-04	9.7E-04

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Br-87	1.8E-06	1.3E+00	1.4E+00	5.5E-01	6.2E-01	8.2E-05	5.0E-04	3.0E-04	3.5E-04
Kr-87	1.4E-04	4.6E-01	3.5E-01	2.8E-01	2.2E-01	3.7E-07	1.5E-06	1.9E-06	1.5E-06
Rb-87	4.9E10	2.5E-03	1.3E-03	1.5E-02	6.5E-03	5.9E-24	1.7E-23	2.9E-22	1.3E-22
Sr-87m	3.2E-04	2.5E-07	9.8E-08	5.8E-06	2.3E-06	9.0E-14	1.9E-13	1.7E-11	7.3E-12
Ge-88	4.1E-09	5.2E-05	1.4E-06	2.7E-08	7.6E-08	1.5E-06	2.1E-07	6.4E-09	1.8E-08
As-88	4.3E-09	1.2E-01	2.0E-03	1.0E-04	1.9E-04	3.3E-03	2.9E-04	2.3E-05	4.5E-05
Se-88	4.8E-08	2.7E-01	4.5E-01	4.2E-02	5.8E-02	6.5E-04	5.8E-03	8.5E-04	1.2E-03
Br-88	5.2E-07	1.4E+00	1.7E+00	4.7E-01	4.9E-01	3.1E-04	2.0E-03	8.6E-04	9.3E-04
Kr-88	3.2E-04	1.7E+00	1.3E+00	7.5E-01	7.3E-01	6.1E-07	2.4E-06	2.2E-06	2.2E-06
Rb-88	3.4E-05	2.2E-02	5.5E-02	5.7E-02	4.1E-02	7.6E-08	1.0E-06	1.6E-06	1.2E-06
Sr-88	NA	7.7E-05	3.6E-05	6.8E-04	3.4E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
As-89	3.8E-09	1.5E-04	2.1E-04	4.6E-06	1.3E-05	4.6E-06	3.4E-05	1.1E-06	3.3E-06
Se-89	1.3E-08	4.9E-02	1.2E-01	5.0E-03	1.1E-02	4.3E-04	5.8E-03	3.7E-04	8.3E-04
Br-89	1.4E-07	1.0E+00	1.3E+00	3.4E-01	3.2E-01	8.6E-04	5.9E-03	2.4E-03	2.3E-03
Kr-89	6.0E-06	3.4E+00	2.6E+00	1.1E+00	1.1E+00	6.6E-05	2.6E-04	1.8E-04	1.9E-04
Rb-89	2.9E-05	2.1E-01	3.9E-01	2.6E-01	2.7E-01	8.0E-07	8.2E-06	8.3E-06	9.1E-06
Sr-89	1.4E-01	1.8E-02	8.3E-04	1.5E-02	5.1E-03	1.5E-11	3.7E-12	1.0E-10	3.6E-11
Y-89m	5.0E-07	1.9E-07	6.7E-08	7.0E-06	3.1E-06	4.3E-11	8.3E-11	1.3E-08	6.2E-09
Se-90	1.4E-08	1.3E-02	2.4E-02	1.2E-03	1.5E-03	1.1E-04	1.1E-03	8.6E-05	1.1E-04

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Br-90	6.0E-08	5.5E-01	7.3E-01	2.1E-01	1.2E-01	1.1E-03	7.4E-03	3.4E-03	1.9E-03
Kr-90	1.0E-06	4.4E+00	4.0E+00	1.1E+00	1.3E+00	4.9E-04	2.4E-03	1.0E-03	1.3E-03
Rb-90m	8.2E-06	7.1E-01	6.9E-01	6.0E-01	4.8E-01	9.9E-06	5.2E-05	7.1E-05	5.9E-05
Rb-90	4.9E-06	1.4E-01	1.3E-01	1.4E-01	9.9E-02	3.2E-06	1.6E-05	2.7E-05	2.0E-05
Sr-90	2.9E+01	7.4E-02	3.4E-02	9.7E-02	4.5E-02	2.9E-13	7.3E-13	3.2E-12	1.6E-12
Y-90	7.3E-03	9.0E-06	4.6E-06	1.9E-04	9.7E-05	1.4E-13	3.9E-13	2.5E-11	1.3E-11
Se-91	8.6E-09	6.7E-04	9.6E-04	0.0E+00	1.1E-04	8.9E-06	6.9E-05	0.0E+00	1.3E-05
Br-91	1.7E-08	2.2E-01	1.4E-01	2.0E-02	3.3E-02	1.5E-03	4.9E-03	1.1E-03	1.9E-03
Kr-91	2.7E-07	3.2E+00	2.9E+00	7.0E-01	9.4E-01	1.3E-03	6.6E-03	2.4E-03	3.4E-03
Rb-91	1.8E-06	2.2E+00	2.0E+00	1.4E+00	1.3E+00	1.4E-04	6.7E-04	7.2E-04	7.0E-04
Sr-91	1.1E-03	2.5E-01	6.9E-01	3.9E-01	2.5E-01	2.7E-08	3.9E-07	3.4E-07	2.3E-07
Y-91	1.6E-01	3.3E-04	1.7E-04	2.5E-03	2.0E-03	2.4E-13	6.6E-13	1.5E-11	1.2E-11
Se-92	5.3E-09	4.2E-05	5.5E-05	2.3E-06	5.8E-06	9.0E-07	6.4E-06	4.1E-07	1.1E-06
Br-92	1.1E-08	2.7E-02	2.1E-02	2.5E-03	4.8E-03	2.9E-04	1.2E-03	2.2E-04	4.4E-04
Kr-92	5.8E-08	1.7E+00	1.4E+00	3.1E-01	4.9E-01	3.3E-03	1.4E-02	5.1E-03	8.3E-03
Rb-92	1.4E-07	3.1E+00	2.8E+00	1.6E+00	1.5E+00	2.5E-03	1.2E-02	1.1E-02	1.1E-02
Sr-92	3.1E-04	1.1E+00	1.6E+00	1.0E+00	9.6E-01	4.0E-07	3.2E-06	3.2E-06	3.1E-06
Y-92	4.0E-04	7.2E-02	2.9E-03	4.5E-02	2.0E-02	2.0E-08	4.4E-09	1.1E-07	4.9E-08
Br-93	3.2E-09	3.1E-03	6.4E-02	6.6E-03	4.9E-04	1.1E-04	1.2E-02	2.0E-03	1.5E-04

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Kr-93	4.1E-08	4.9E-01	3.1E-01	6.4E-02	1.4E-01	1.4E-03	4.6E-03	1.5E-03	3.3E-03
Rb-93	1.9E-07	3.1E+00	3.4E+00	1.4E+00	1.5E+00	1.9E-03	1.1E-02	7.0E-03	7.8E-03
Sr-93	1.4E-05	2.6E+00	2.1E+00	2.1E+00	2.0E+00	2.1E-05	9.3E-05	1.5E-04	1.4E-04
Y-93	1.2E-03	1.1E-01	2.1E-01	1.7E-01	1.5E-01	1.1E-08	1.1E-07	1.4E-07	1.3E-07
Zr-93	1.5E+06	1.4E-04	4.9E-05	1.7E-03	1.2E-03	1.0E-20	2.0E-20	1.1E-18	7.6E-19
Nb-93m	1.6E+01	8.5E-10	2.1E-10	9.9E-08	4.8E-08	6.1E-21	8.1E-21	5.9E-18	3.0E-18
Se-94	4.8E-15	1.7E-08	1.6E-08	2.3E-07	2.5E-09	4.1E-04	2.0E-03	4.6E-02	5.1E-04
Br-94	2.2E-09	1.7E-04	8.1E-05	2.7E-03	2.3E-05	8.6E-06	2.3E-05	1.2E-03	1.0E-05
Kr-94	6.7E-09	8.7E-02	6.2E-02	2.2E-02	2.4E-02	1.5E-03	5.7E-03	3.1E-03	3.6E-03
Rb-94	8.6E-08	1.6E+00	1.9E+00	7.0E-01	6.5E-01	2.1E-03	1.4E-02	7.8E-03	7.5E-03
Sr-94	2.4E-06	4.5E+00	3.8E+00	2.9E+00	2.9E+00	2.2E-04	9.8E-04	1.2E-03	1.2E-03
Y-94	3.6E-05	3.9E-01	6.8E-01	6.8E-01	7.3E-01	1.3E-06	1.2E-05	1.8E-05	2.0E-05
Zr-94	NA	2.0E-02	1.3E-03	3.0E-02	1.5E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Kr-95	2.5E-08	7.2E-03	2.3E-02	1.1E-03	3.1E-03	3.3E-05	5.6E-04	4.3E-05	1.2E-04
Rb-95	1.2E-08	7.6E-01	9.0E-01	4.3E-01	2.9E-01	7.3E-03	4.6E-02	3.5E-02	2.4E-02
Sr-95	8.0E-07	4.5E+00	4.4E+00	2.6E+00	2.9E+00	6.5E-04	3.4E-03	3.1E-03	3.6E-03
Y-95	2.0E-05	1.1E+00	1.2E+00	1.7E+00	1.4E+00	6.5E-06	3.7E-05	8.2E-05	7.1E-05
Zr-95	1.8E-01	1.3E-01	1.5E-02	1.3E-01	9.3E-02	8.3E-11	5.2E-11	6.8E-10	5.3E-10
Nb-95m	9.9E-03	2.5E-05	9.1E-07	1.3E-04	3.9E-05	2.9E-13	5.6E-14	1.3E-11	4.0E-12

[a] *The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Nb-95	9.6E-02	1.1E-04	4.4E-06	5.7E-04	1.9E-04	1.3E-13	2.8E-14	5.6E-12	2.0E-12
Mo-95	NA	4.9E-10	1.5E-10	9.3E-08	4.9E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Se-96	---	1.3E-11	3.1E-12	4.8E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Br-96	2.8E-09	1.9E-06	2.3E-07	6.2E-07	2.3E-08	7.8E-08	5.0E-08	2.1E-07	8.0E-09
Kr-96	9.3E-09	3.8E-02	2.3E-03	8.2E-03	2.5E-04	4.7E-04	1.5E-04	8.4E-04	2.6E-05
Rb-96	6.3E-09	1.7E-01	2.3E-01	3.9E-02	6.0E-02	3.1E-03	2.2E-02	5.9E-03	9.5E-03
Sr-96	3.4E-08	3.6E+00	4.4E+00	1.8E+00	2.0E+00	1.2E-02	7.9E-02	5.1E-02	5.8E-02
Y-96m	3.0E-07	2.0E+00	1.4E+00	2.2E+00	2.1E+00	7.6E-04	2.7E-03	7.0E-03	6.8E-03
Y-96m	1.7E-07	2.2E-01	1.3E-01	2.5E-01	2.1E-01	1.5E-04	4.9E-04	1.4E-03	1.2E-03
Kr-97	3.2E-09	3.0E-05	1.2E-04	1.6E-03	1.2E-05	1.1E-06	2.2E-05	4.9E-04	3.8E-06
Rb-97	5.4E-09	3.8E-02	5.4E-02	5.4E-03	1.1E-02	8.1E-04	6.2E-03	9.6E-04	2.0E-03
Sr-97	1.4E-08	1.7E+00	2.4E+00	7.9E-01	8.6E-01	1.4E-02	1.1E-01	5.5E-02	6.2E-02
Y-97	1.2E-07	3.1E+00	3.0E+00	3.0E+00	3.0E+00	3.0E-03	1.6E-02	2.4E-02	2.5E-02
Zr-97	1.9E-03	1.1E+00	5.6E-01	1.6E+00	1.4E+00	6.5E-08	1.8E-07	7.9E-07	7.5E-07
~~Nb-97m~~	~~1.7E-06~~	~~2.5E-03~~	~~4.4E-04~~	~~1.5E-02~~	~~5.3E-03~~	~~1.7E-07~~	~~1.6E-07~~	8.7E-06	3.1E-06
Nb-97	1.4E-04	1.1E-02	2.2E-03	6.5E-02	2.6E-02	8.8E-09	9.5E-09	4.4E-07	1.8E-07
Kr-98	5.1E-09	1.6E-03	4.3E-06	2.2E-07	3.9E-07	3.7E-05	5.2E-07	4.2E-08	7.5E-08
Rb-98	3.4E-09	2.4E-03	5.4E-03	6.8E-04	9.3E-04	8.0E-05	9.7E-04	1.9E-04	2.7E-04
Sr-98	2.1E-08	8.1E-01	1.0E+00	3.3E-01	2.6E-01	4.5E-03	3.1E-02	1.5E-02	1.3E-02

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Y-98m	6.7E-08	1.1E+00	1.4E+00	1.2E+00	1.1E+00	1.9E-03	1.3E-02	1.7E-02	1.6E-02
Y-98	1.9E-08	1.1E+00	1.4E+00	1.2E+00	1.1E+00	6.8E-03	4.6E-02	6.1E-02	5.6E-02
Zr-98	9.7E-07	2.6E+00	2.0E+00	2.9E+00	3.1E+00	3.0E-04	1.3E-03	2.9E-03	3.2E-03
Nb-98m	9.7E-05	3.9E-02	5.0E-03	4.5E-02	3.7E-02	4.6E-08	3.2E-08	4.4E-07	3.8E-07
Nb-98	9.2E-08	1.2E-01	1.8E-02	1.3E-01	1.3E-01	1.4E-04	1.2E-04	1.4E-03	1.4E-03
Sr-99	8.5E-09	1.3E-01	2.2E-01	3.8E-02	4.9E-02	1.8E-03	1.6E-02	4.2E-03	5.7E-03
Y-99	4.7E-08	2.0E+00	2.3E+00	1.4E+00	1.3E+00	4.8E-03	3.0E-02	3.0E-02	2.7E-02
Zr-99	7.0E-08	3.6E+00	3.4E+00	3.8E+00	4.0E+00	5.9E-03	3.0E-02	5.2E-02	5.7E-02
Nb-99m	4.9E-06	4.1E-01	1.4E-01	8.8E-01	6.3E-01	9.4E-06	1.8E-05	1.7E-04	1.3E-04
Nb-99	4.8E-07	3.0E-02	1.2E-02	7.5E-02	5.4E-02	7.2E-06	1.6E-05	1.5E-04	1.1E-04
Mo-99	7.5E-03	4.3E-02	7.2E-04	3.8E-02	1.3E-02	6.5E-10	5.9E-11	4.8E-09	1.7E-09
Tc-99m	6.9E-04	2.9E-08	9.9E-09	2.8E-06	1.5E-06	4.8E-15	8.9E-15	3.9E-12	2.2E-12
Tc-99	2.1E+05	1.2E-07	4.9E-08	1.2E-05	7.3E-06	6.6E-23	1.4E-22	5.4E-20	3.4E-20
Kr-100	4.8E-15	1.2E-06	9.6E-10	6.5E-11	1.0E-10	2.8E-02	1.2E-04	1.3E-05	2.1E-05
Rb-100	1.7E-09	3.5E-02	1.6E-05	2.1E-06	2.5E-06	2.4E-03	5.7E-06	1.2E-06	1.5E-06
Sr-100	6.4E-09	8.2E-03	3.6E-02	6.8E-03	6.7E-03	1.5E-04	3.4E-03	1.0E-03	1.1E-03
Y-100	2.3E-08	5.7E-01	8.7E-01	3.5E-01	4.4E-01	2.8E-03	2.3E-02	1.4E-02	1.9E-02
Zr-100	2.3E-07	5.0E+00	4.9E+00	4.8E+00	4.4E+00	2.5E-03	1.3E-02	2.0E-02	1.9E-02
Nb-100m	9.5E-08	3.2E-01	2.5E-01	7.5E-01	8.2E-01	3.8E-04	1.6E-03	7.5E-03	8.6E-03

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Nb-100	4.8E-08	3.2E-01	2.5E-01	7.5E-01	8.2E-01	7.7E-04	3.2E-03	1.5E-02	1.7E-02
Mo-100	NA	7.3E-02	1.1E-02	1.4E-01	1.1E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tc-100	5.0E-07	5.6E-06	2.4E-06	3.1E-04	1.9E-04	1.3E-09	2.9E-09	5.9E-07	3.8E-07
Sr-101	3.7E-09	4.5E-03	2.6E-03	2.9E-04	4.7E-04	1.4E-04	4.3E-04	7.5E-05	1.3E-04
Y-101	1.4E-08	2.8E-01	2.8E-01	8.4E-02	1.1E-01	2.3E-03	1.3E-02	5.9E-03	8.2E-03
Zr-101	7.6E-08	2.8E+00	3.4E+00	2.3E+00	2.7E+00	4.2E-03	2.8E-02	2.9E-02	3.5E-02
Nb-101	2.3E-07	1.9E+00	1.4E+00	3.5E+00	3.3E+00	9.8E-04	3.7E-03	1.5E-02	1.4E-02
Mo-101	2.8E-05	1.9E-01	6.9E-02	1.4E-01	5.7E-01	7.7E-07	1.5E-06	4.8E-06	2.0E-05
Tc-101	2.7E-05	1.6E-04	7.6E-05	1.2E-02	3.7E-03	6.8E-10	1.7E-09	4.4E-07	1.4E-07
Ru-101	NA	1.6E-08	6.4E-09	2.4E-06	2.0E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Rh-101m	1.2E-02	0.0E+00	0.0E+00	3.8E-11	2.9E-11	0.0E+00	0.0E+00	3.1E-18	2.4E-18
Rh-101	3.3E+00	3.3E-11	0.0E+00	9.0E-12	5.9E-12	1.1E-21	0.0E+00	2.6E-21	1.8E-21
Sr-102	2.2E-09	1.7E-04	1.7E-04	8.0E-06	2.4E-05	9.2E-06	4.8E-05	3.6E-06	1.1E-05
Y-102	1.1E-08	2.7E-01	4.6E-02	6.1E-03	1.6E-02	2.7E-03	2.5E-03	5.1E-04	1.4E-03
Zr-102	9.2E-08	1.8E+00	2.2E+00	1.2E+00	1.3E+00	2.2E-03	1.5E-02	1.3E-02	1.4E-02
Nb-102	4.1E-08	1.6E+00	1.7E+00	3.1E+00	3.5E+00	4.4E-03	2.6E-02	7.2E-02	8.5E-02
Mo-102	2.1E-05	6.5E-01	3.7E-01	1.8E+00	1.8E+00	3.5E-06	1.0E-05	7.8E-05	8.5E-05
Tc-102m	8.4E-06	9.6E-03	4.9E-04	3.4E-02	1.6E-02	1.3E-07	3.6E-08	3.9E-06	1.9E-06
Tc-102	1.7E-07	9.6E-03	4.9E-04	3.4E-02	1.6E-02	6.5E-06	1.8E-06	1.9E-04	9.3E-05

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ru-102	NA	9.8E-07	4.0E-07	7.7E-05	6.9E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Y-103	7.0E-09	2.6E-03	5.6E-03	1.0E-03	1.4E-03	4.2E-05	4.9E-04	1.4E-04	2.0E-04
Zr-103	4.1E-08	5.0E-01	6.3E-01	2.2E-01	3.2E-01	1.4E-03	9.3E-03	5.2E-03	7.8E-03
Nb-103	4.8E-08	1.4E+00	1.8E+00	2.7E+00	2.9E+00	3.4E-03	2.3E-02	5.4E-02	6.0E-02
Mo-103	2.1E-06	1.0E+00	8.0E-01	3.8E+00	3.4E+00	5.6E-05	2.3E-04	1.7E-03	1.6E-03
Tc-103	1.7E-06	8.2E-02	9.4E-03	2.5E-01	2.1E-01	5.5E-06	3.4E-06	1.4E-04	1.2E-04
Ru-103	1.1E-01	2.4E-05	9.9E-06	1.3E-03	1.3E-03	2.5E-14	5.7E-14	1.1E-11	1.2E-11
Rh-103m	1.1E-04	4.3E-10	1.5E-10	2.2E-07	2.2E-07	4.6E-16	8.6E-16	2.0E-12	2.1E-12
Sr-104	5.2E-09	1.3E-07	6.9E-08	9.4E-09	8.6E-09	2.9E-09	8.2E-09	1.7E-09	1.7E-09
Y-104	6.3E-09	5.7E-04	2.3E-04	7.3E-05	6.5E-05	1.0E-05	2.3E-05	1.1E-05	1.0E-05
Zr-104	3.8E-08	8.3E-02	1.2E-01	6.1E-02	5.6E-02	2.5E-04	1.9E-03	1.5E-03	1.5E-03
Nb-104	1.6E-07	5.7E-01	7.1E-01	1.2E+00	1.2E+00	4.2E-04	2.8E-03	7.1E-03	7.9E-03
Mo-104	1.9E-06	1.1E+00	1.2E+00	4.3E+00	4.6E+00	6.8E-05	3.9E-04	2.2E-03	2.4E-03
Tc-104	3.5E-05	9.3E-02	3.2E-02	5.4E-01	6.7E-01	3.1E-07	5.6E-07	1.5E-05	1.9E-05
Ru-104	NA	3.3E-04	1.6E-04	2.4E-02	1.5E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zr-105	1.9E-08	1.2E-01	5.5E-04	6.4E-03	4.9E-03	7.0E-04	1.8E-05	3.2E-04	2.6E-04
Nb-105	9.2E-08	1.4E-01	2.8E-01	4.9E-01	3.9E-01	1.7E-04	1.9E-03	5.1E-03	4.2E-03
Mo-105	1.1E-06	6.7E-01	9.2E-01	3.5E+00	3.4E+00	6.7E-05	4.9E-04	2.9E-03	2.9E-03
Tc-105	1.4E-05	4.9E-02	7.5E-03	1.6E+00	1.5E+00	3.8E-07	3.2E-07	1.1E-04	1.0E-04

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ru-105	5.1E-04	1.1E-07	1.0E-07	4.5E-02	8.9E-02	2.5E-14	1.2E-13	8.6E-08	1.7E-07
Rh-105m	1.4E-06	0.0E+00	8.4E-09	2.1E-05	2.2E-05	0.0E+00	3.8E-12	1.5E-08	1.6E-08
Rh-105	4.0E-03	0.0E+00	6.2E-08	1.4E-04	1.6E-04	0.0E+00	9.4E-15	3.3E-11	4.0E-11
Pd-105	NA	0.0E+00	0.0E+00	2.4E-08	3.3E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zr-106	2.9E-08	1.7E-06	2.7E-05	1.8E-04	3.2E-04	6.7E-09	5.9E-07	6.1E-06	1.1E-05
Nb-106	2.9E-08	1.6E-02	4.4E-02	3.5E-02	6.7E-02	6.2E-05	9.2E-04	1.1E-03	2.3E-03
Mo-106	2.8E-07	3.6E-01	4.8E-01	2.2E+00	1.9E+00	1.5E-04	1.1E-03	7.5E-03	7.0E-03
Tc-106	1.1E-06	2.7E-02	1.0E-02	1.8E+00	2.0E+00	2.7E-06	5.6E-06	1.5E-03	1.7E-03
Ru-106	1.0E+00	9.1E-07	8.7E-07	3.2E-01	3.9E-01	1.0E-16	5.2E-16	3.0E-10	3.8E-10
Rh-106m	2.5E-04	0.0E+00	0.0E+00	2.2E-04	1.1E-03	0.0E+00	0.0E+00	8.5E-10	4.4E-09
Rh-106	9.5E-07	0.0E+00	0.0E+00	2.2E-04	1.1E-03	0.0E+00	0.0E+00	2.2E-07	1.2E-06
Pd-106	NA	0.0E+00	0.0E+00	9.2E-07	1.5E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ag-106m	2.3E-02	0.0E+00	0.0E+00	8.1E-12	1.7E-11	0.0E+00	0.0E+00	3.4E-19	7.3E-19
Nb-107	9.8E-09	2.3E-03	1.0E-02	9.8E-03	7.7E-03	2.7E-05	6.4E-04	9.5E-04	7.8E-04
Mo-107	1.1E-07	1.2E-01	2.7E-01	5.9E-01	5.6E-01	1.3E-04	1.5E-03	5.1E-03	5.0E-03
Tc-107	6.7E-07	2.2E-02	2.6E-02	1.8E+00	1.8E+00	3.8E-06	2.4E-05	2.6E-03	2.7E-03
Ru-107	7.2E-06	4.9E-06	8.4E-06	8.4E-01	8.2E-01	7.8E-11	7.2E-10	1.1E-04	1.1E-04
Rh-107	4.1E-05	0.0E+00	0.0E+00	7.6E-02	1.7E-02	0.0E+00	0.0E+00	1.8E-06	4.1E-07
Pd-107m	6.6E-07	0.0E+00	0.0E+00	1.3E-05	2.3E-05	0.0E+00	0.0E+00	1.8E-08	3.4E-08

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Pd-107	6.5E+06	0.0E+00	0.0E+00	6.8E-06	1.0E-05	0.0E+00	0.0E+00	1.0E-21	1.5E-21
Ag-107m	1.4E-06	0.0E+00	0.0E+00	8.4E-10	1.8E-09	0.0E+00	0.0E+00	5.8E-13	1.3E-12
Ag-107	NA	0.0E+00	0.0E+00	1.3E-10	2.5E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Zr-108	1.2E-08	3.1E-10	1.9E-08	4.6E-07	1.5E-07	3.0E-12	9.5E-10	3.6E-08	1.3E-08
Nb-108	6.0E-09	9.0E-05	8.2E-04	9.3E-04	3.5E-04	1.7E-06	8.4E-05	1.5E-04	5.8E-05
Mo-108	3.5E-08	3.0E-02	1.1E-01	2.2E-01	9.7E-02	1.0E-04	1.9E-03	6.0E-03	2.8E-03
Tc-108	1.6E-07	2.4E-02	2.2E-02	6.3E-01	7.6E-01	1.7E-05	8.5E-05	3.7E-03	4.6E-03
Ru-108	8.6E-06	1.7E-05	4.9E-05	1.3E+00	1.1E+00	2.2E-10	3.5E-09	1.4E-04	1.3E-04
Rh-108m	1.1E-05	0.0E+00	6.8E-12	2.0E-02	2.9E-02	0.0E+00	3.7E-16	1.7E-06	2.5E-06
Rh-108	5.4E-07	0.0E+00	6.8E-12	2.0E-02	2.9E-02	0.0E+00	7.8E-15	3.5E-05	5.3E-05
Nb-109	6.0E-09	4.8E-04	1.6E-03	1.8E-09	4.0E-11	9.2E-06	1.6E-04	2.8E-10	6.6E-12
Mo-109	1.6E-08	1.6E-02	4.2E-02	5.9E-03	1.6E-04	1.1E-04	1.6E-03	3.6E-04	1.0E-05
Tc-109	2.8E-08	1.3E-02	3.4E-02	4.0E-01	1.9E-01	5.6E-05	7.6E-04	1.4E-02	6.9E-03
Ru-109	1.1E-06	1.7E-03	4.0E-03	1.0E+00	8.3E-01	1.8E-07	2.2E-06	8.7E-04	7.5E-04
Rh-109m	1.6E-06	2.1E-06	5.3E-06	3.6E-02	7.6E-03	1.5E-10	2.0E-09	2.2E-05	4.7E-06
Rh-109	2.5E-06	2.1E-06	5.3E-06	3.6E-02	7.6E-03	9.3E-11	1.3E-09	1.4E-05	2.9E-06
Pd-109m	8.9E-06	5.5E-10	1.6E-09	2.6E-07	2.6E-07	7.0E-15	1.1E-13	2.8E-11	2.9E-11
Pd-109	1.5E-03	2.9E-10	7.0E-10	1.4E-07	1.2E-07	2.2E-17	2.8E-16	8.8E-14	7.6E-14
Zr-110	4.8E-15	9.3E-09	4.3E-08	0.0E+00	0.0E+00	2.2E-04	5.6E-03	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Nb-110	5.4E-09	1.5E-05	5.5E-05	0.0E+00	0.0E+00	3.3E-07	6.3E-06	0.0E+00	0.0E+00
Mo-110	9.5E-09	3.9E-03	1.1E-02	8.3E-06	9.5E-06	4.7E-05	7.2E-04	8.4E-07	1.0E-06
Tc-110	2.8E-08	1.2E-02	3.1E-02	4.0E-02	4.2E-02	4.8E-05	6.8E-04	1.4E-03	1.5E-03
Ru-110	3.8E-07	9.9E-03	2.3E-02	5.7E-01	5.8E-01	3.0E-06	3.8E-05	1.4E-03	1.5E-03
Rh-110m	9.2E-07	5.7E-05	1.3E-04	1.5E-02	1.4E-02	7.1E-09	8.9E-08	1.6E-05	1.6E-05
Rh-110	9.8E-08	5.7E-05	1.3E-04	1.5E-02	1.4E-02	6.6E-08	8.3E-07	1.5E-04	1.5E-04
Pd-110	NA	2.2E-07	5.1E-07	4.4E-06	3.9E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ag-110m	6.8E-01	2.3E-12	6.5E-12	0.0E+00	0.0E+00	3.8E-22	5.8E-21	0.0E+00	0.0E+00
Mo-111	1.5E-08	2.3E-04	7.0E-04	2.5E-07	3.1E-07	1.8E-06	2.9E-05	1.6E-08	2.1E-08
Tc-111	9.5E-09	4.5E-03	1.2E-02	6.7E-03	7.9E-03	5.4E-05	7.8E-04	6.7E-04	8.2E-04
Ru-111	6.7E-08	1.2E-02	2.8E-02	2.5E-01	3.0E-01	2.0E-05	2.6E-04	3.5E-03	4.4E-03
Rh-111	3.5E-07	8.8E-04	2.1E-03	4.4E-02	5.2E-02	2.9E-07	3.7E-06	1.2E-04	1.5E-04
Pd-111m	6.3E-04	4.7E-06	1.2E-05	1.5E-05	2.0E-05	8.6E-13	1.1E-11	2.3E-11	3.1E-11
Pd-111	4.5E-05	2.5E-06	5.2E-06	8.1E-06	8.8E-06	6.5E-12	7.1E-11	1.7E-10	2.0E-10
Ag-111m	2.1E-06	8.3E-10	2.1E-09	3.3E-12	3.8E-12	4.6E-14	6.3E-13	1.5E-15	1.9E-15
Ag-111	2.0E-02	1.2E-10	2.9E-10	0.0E+00	0.0E+00	7.0E-19	8.7E-18	0.0E+00	0.0E+00
Mo-112	3.1E-08	9.7E-06	4.4E-05	6.0E-09	1.0E-08	3.6E-08	8.8E-07	1.8E-10	3.3E-10
Tc-112	8.2E-09	6.9E-04	2.5E-03	6.1E-04	9.4E-04	9.5E-06	1.8E-04	7.1E-05	1.1E-04
Ru-112	5.7E-08	9.9E-03	2.9E-02	9.2E-02	1.4E-01	2.0E-05	3.1E-04	1.5E-03	2.4E-03

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Rh-112	2.2E-07	2.3E-03	6.1E-03	3.6E-02	4.9E-02	1.2E-06	1.7E-05	1.6E-04	2.3E-04
Pd-112	2.4E-03	1.3E-04	3.0E-04	9.5E-05	1.2E-04	6.1E-12	7.6E-11	3.8E-11	5.1E-11
Ag-112	3.6E-04	8.3E-07	1.5E-07	5.9E-11	7.6E-11	2.7E-13	2.6E-13	1.6E-16	2.1E-16
Cd-112	NA	1.1E-09	1.2E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tc-113	4.8E-09	1.4E-04	4.9E-04	7.9E-05	1.3E-04	3.4E-06	6.3E-05	1.6E-05	2.8E-05
Ru-113	1.6E-08	6.1E-03	1.6E-02	3.8E-02	6.2E-02	4.3E-05	5.9E-04	2.2E-03	3.8E-03
Rh-113	8.9E-08	6.8E-03	1.5E-02	4.4E-02	6.5E-02	8.8E-06	1.0E-04	4.7E-04	7.3E-04
Pd-113	2.9E-06	1.2E-03	2.0E-03	3.7E-04	5.5E-04	4.6E-08	4.3E-07	1.2E-07	1.9E-07
Ag-113m	2.2E-06	3.6E-06	5.7E-06	1.2E-09	1.6E-09	1.9E-10	1.6E-09	5.3E-13	7.2E-13
Ag-113	6.1E-04	5.4E-07	7.8E-07	1.8E-10	2.2E-10	1.0E-13	7.9E-13	2.9E-16	3.5E-16
Cd-113m	1.4E+01	8.7E-10	1.4E-09	0.0E+00	0.0E+00	7.1E-21	5.9E-20	0.0E+00	0.0E+00
Cd-113	7.7E15	2.6E-10	3.6E-10	0.0E+00	0.0E+00	3.9E-36	2.9E-35	0.0E+00	0.0E+00
Mo-114	1.2E-08	4.4E-09	4.6E-08	5.4E-07	5.1E-07	4.2E-11	2.4E-09	4.4E-08	4.2E-08
Tc-114	4.8E-09	7.0E-06	4.5E-05	2.7E-04	2.9E-04	1.7E-07	5.8E-06	5.3E-05	6.1E-05
Ru-114	1.8E-08	1.7E-03	7.1E-03	1.6E-02	2.1E-02	1.1E-05	2.4E-04	8.4E-04	1.2E-03
Rh-114	5.7E-08	5.0E-03	1.6E-02	3.2E-02	5.0E-02	1.0E-05	1.7E-04	5.4E-04	8.7E-04
Pd-114	4.7E-06	4.2E-03	9.6E-03	1.2E-02	2.3E-02	1.0E-07	1.2E-06	2.5E-06	4.8E-06
Ag-114	1.5E-07	9.2E-04	8.6E-05	1.5E-04	3.4E-04	7.2E-07	3.6E-07	9.8E-07	2.3E-06
Cd-114	NA	7.7E-08	1.3E-07	2.2E-07	6.5E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).
NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable
--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
In-114m	1.4E-01	0.0E+00	1.3E-12	5.6E-12	2.1E-11	0.0E+00	5.9E-21	3.9E-20	1.6E-19
In-114	2.3E-06	0.0E+00	0.0E+00	1.9E-12	6.0E-12	0.0E+00	0.0E+00	7.8E-16	2.6E-15
Ru-115	2.3E-08	2.6E-04	1.5E-03	1.8E-03	2.9E-03	1.3E-06	3.8E-05	7.3E-05	1.2E-04
Rh-115	2.3E-08	3.6E-03	1.4E-02	1.8E-02	3.1E-02	1.8E-05	3.5E-04	7.3E-04	1.3E-03
Pd-115	1.6E-06	7.1E-03	1.8E-02	2.2E-02	4.4E-02	5.2E-07	7.1E-06	1.3E-05	2.8E-05
Ag-115m	5.9E-07	1.4E-03	3.7E-04	7.2E-04	1.6E-03	2.7E-07	3.9E-07	1.2E-06	2.7E-06
Ag-115	3.8E-05	1.9E-04	3.7E-04	7.2E-04	1.6E-03	5.8E-10	6.0E-09	1.8E-08	4.2E-08
Cd-115m	1.2E-01	5.5E-06	2.4E-06	6.8E-06	1.9E-05	5.2E-15	1.2E-14	5.3E-14	1.6E-13
Cd-115	6.1E-03	9.0E-07	6.4E-07	2.0E-06	5.1E-06	1.7E-14	6.5E-14	3.2E-13	8.3E-13
In-115m	5.1E-04	3.8E-11	3.7E-11	3.3E-10	1.0E-09	8.6E-18	4.5E-17	6.2E-16	2.0E-15
In-115	4.4E+14	1.6E-10	1.8E-10	1.4E-09	5.0E-09	4.3E-35	2.5E-34	3.1E-33	1.1E-32
Mo-116	---	0.0E+00	5.9E-12	1.2E-11	1.2E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tc-116	3.6E-09	6.3E-09	9.2E-08	1.5E-07	1.5E-07	2.0E-10	1.5E-08	3.8E-08	4.1E-08
Ru-116	5.4E-08	2.5E-05	2.0E-04	2.0E-04	2.1E-04	5.2E-08	2.3E-06	3.5E-06	3.9E-06
Rh-116	2.2E-08	8.7E-04	4.8E-03	6.7E-03	7.5E-03	4.5E-06	1.3E-04	2.9E-04	3.4E-04
Pd-116	3.8E-07	6.8E-03	2.6E-02	3.6E-02	4.3E-02	2.1E-06	4.3E-05	9.0E-05	1.1E-04
Ag-116m	2.9E-07	7.7E-04	1.3E-03	3.8E-03	4.7E-03	3.1E-07	2.8E-06	1.3E-05	1.6E-05
Ag-116	5.1E-06	4.7E-03	1.3E-03	3.8E-03	4.7E-03	1.1E-07	1.6E-07	7.2E-07	9.2E-07
Cd-116	NA	3.0E-05	5.5E-05	2.6E-04	3.4E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
In-116m	1.0E-04	3.9E-09	5.8E-09	1.1E-07	1.6E-07	4.3E-15	3.5E-14	1.0E-12	1.5E-12
Ru-117	1.1E-08	2.5E-06	1.5E-05	8.6E-06	1.2E-05	2.7E-08	8.6E-07	7.5E-07	1.1E-06
Rh-117	1.4E-08	4.7E-04	1.9E-03	1.4E-03	2.1E-03	3.8E-06	8.2E-05	9.8E-05	1.5E-04
Pd-117	1.4E-07	8.8E-03	2.4E-02	2.2E-02	3.5E-02	7.2E-06	1.1E-04	1.5E-04	2.5E-04
Ag-117m	1.7E-07	1.5E-03	5.1E-03	9.5E-03	1.5E-02	1.0E-06	1.9E-05	5.4E-05	8.7E-05
Ag-117	2.3E-06	1.5E-03	5.1E-03	9.5E-03	1.5E-02	7.5E-08	1.3E-06	3.9E-06	6.3E-06
Cd-117m	3.9E-04	3.7E-04	4.6E-04	1.5E-03	2.7E-03	1.1E-10	7.3E-10	3.7E-09	6.9E-09
Cd-117	2.8E-04	1.1E-04	1.2E-04	4.5E-04	7.2E-04	4.5E-11	2.6E-10	1.5E-09	2.5E-09
In-117m	2.2E-04	8.6E-08	1.2E-07	1.7E-06	2.6E-06	4.5E-14	3.2E-13	7.1E-12	1.2E-11
In-117	8.4E-05	3.7E-07	5.7E-07	7.0E-06	1.3E-05	5.0E-13	4.2E-12	8.0E-11	1.5E-10
Ru-118	2.1E-08	6.9E-08	6.9E-07	2.2E-07	3.5E-07	3.8E-10	2.0E-08	1.0E-08	1.7E-08
Rh-118	9.5E-09	3.6E-05	2.5E-04	1.3E-04	2.0E-04	4.4E-07	1.6E-05	1.3E-05	2.0E-05
Pd-118	6.7E-08	3.2E-03	1.5E-02	8.6E-03	1.4E-02	5.5E-06	1.4E-04	1.2E-04	2.1E-04
Ag-118m	7.6E-08	3.0E-03	7.2E-03	9.9E-03	1.6E-02	4.5E-06	5.8E-05	1.2E-04	2.1E-04
Ag-118	1.3E-07	3.4E-03	7.2E-03	9.9E-03	1.6E-02	3.1E-06	3.5E-05	7.5E-05	1.2E-04
Cd-118	9.6E-05	1.7E-03	3.8E-03	3.9E-03	1.4E-02	2.1E-09	2.5E-08	3.9E-08	1.5E-07
In-118m	8.4E-06	1.7E-06	2.9E-06	1.9E-05	4.5E-05	2.3E-11	2.1E-10	2.2E-09	5.4E-09
In-118	1.6E-07	5.1E-06	1.0E-05	5.8E-05	1.6E-04	3.7E-09	4.0E-08	3.5E-07	1.0E-06
Sn-118	NA	4.1E-09	7.0E-09	1.3E-07	3.8E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ru-119	6.2E-09	6.6E-10	1.4E-08	3.1E-09	5.2E-09	1.2E-11	1.4E-09	4.8E-10	8.3E-10
Rh-119	1.5E-08	1.9E-06	2.7E-05	8.2E-06	1.3E-05	1.4E-08	1.1E-06	5.3E-07	8.8E-07
Pd-119	2.9E-08	4.4E-04	4.5E-03	1.7E-03	2.8E-03	1.7E-06	9.7E-05	5.5E-05	9.7E-05
Ag-119	6.7E-08	7.3E-03	1.9E-02	1.4E-02	2.4E-02	1.2E-05	1.7E-04	2.1E-04	3.5E-04
Cd-119m	4.2E-06	2.3E-03	5.8E-03	7.7E-03	1.4E-02	6.2E-08	8.6E-07	1.8E-06	3.2E-06
Cd-119	5.1E-06	2.5E-03	5.8E-03	7.7E-03	1.4E-02	5.5E-08	7.0E-07	1.4E-06	2.6E-06
In-119m	3.4E-05	1.6E-05	3.5E-05	1.7E-04	2.7E-04	5.4E-11	6.3E-10	4.8E-09	7.7E-09
In-119	4.4E-06	4.7E-04	1.7E-04	7.2E-04	1.3E-03	1.2E-08	2.4E-08	1.6E-07	2.9E-07
Sn-119m	8.0E-01	1.1E-07	2.6E-07	3.7E-06	7.2E-06	1.6E-17	2.0E-16	4.4E-15	8.9E-15
Ru-120	1.1E-08	3.0E-10	1.8E-10	3.3E-11	5.3E-11	3.1E-12	1.0E-11	2.9E-12	4.7E-12
Rh-120	5.5E-09	2.4E-06	1.1E-06	2.8E-07	4.4E-07	5.0E-08	1.2E-07	4.8E-08	8.0E-08
Pd-120	1.6E-08	2.7E-03	9.4E-04	2.4E-04	4.1E-04	2.0E-05	3.6E-05	1.5E-05	2.6E-05
Ag-120	3.9E-08	8.8E-04	9.4E-03	5.7E-03	9.8E-03	2.6E-06	1.5E-04	1.4E-04	2.5E-04
Cd-120	1.6E-06	8.4E-03	2.4E-02	2.1E-02	3.9E-02	6.0E-07	9.1E-06	1.3E-05	2.4E-05
In-120m	1.5E-06	3.2E-04	5.3E-04	1.6E-03	3.1E-03	2.4E-08	2.2E-07	1.0E-06	2.0E-06
In-120	9.8E-08	3.2E-04	5.3E-04	1.6E-03	3.1E-03	3.7E-07	3.3E-06	1.6E-05	3.1E-05
Sn-120	NA	3.0E-06	8.9E-06	7.3E-05	1.5E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sb-120m	1.6E-02	1.3E-10	4.6E-10	2.5E-08	5.8E-08	9.5E-19	1.8E-17	1.5E-15	3.7E-15
Rh-121	7.9E-09	1.4E-08	4.3E-08	9.1E-09	1.2E-08	2.1E-10	3.3E-09	1.1E-09	1.5E-09

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).
NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable
--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Pd-121	2.0E-08	4.7E-05	1.0E-04	2.5E-05	3.6E-05	2.7E-07	3.1E-06	1.2E-06	1.7E-06
Ag-121	2.5E-08	2.6E-03	4.8E-03	2.4E-03	3.5E-03	1.2E-05	1.2E-04	9.2E-05	1.4E-04
Cd-121	4.3E-07	7.2E-03	2.7E-02	2.3E-02	3.7E-02	1.9E-06	3.9E-05	5.0E-05	8.7E-05
In-121m	7.2E-06	3.2E-04	8.4E-04	2.3E-03	3.5E-03	5.1E-09	7.2E-08	3.0E-07	4.8E-07
In-121	7.3E-07	2.5E-03	4.1E-03	9.8E-03	1.7E-02	3.9E-07	3.5E-06	1.3E-05	2.3E-05
Sn-121m	4.4E+01	2.8E-05	8.2E-05	5.4E-04	1.1E-03	7.3E-17	1.2E-15	1.2E-14	2.5E-14
Sn-121	3.1E-03	3.6E-04	2.9E-05	2.2E-04	3.9E-04	1.3E-11	5.8E-12	6.8E-11	1.2E-10
Rh-122	3.4E-09	2.9E-10	8.1E-10	1.3E-10	1.6E-10	9.6E-12	1.5E-10	3.7E-11	4.6E-11
Pd-122	4.5E-08	4.8E-06	1.0E-05	1.6E-06	2.1E-06	1.2E-08	1.4E-07	3.5E-08	4.7E-08
Ag-122	1.7E-08	6.7E-04	1.2E-03	4.7E-04	6.4E-04	4.6E-06	4.4E-05	2.6E-05	3.8E-05
Cd-122	1.7E-07	1.2E-02	2.7E-02	1.7E-02	2.5E-02	8.1E-06	1.0E-04	9.6E-05	1.5E-04
In-122m	3.4E-07	1.3E-03	5.4E-03	1.1E-02	1.7E-02	4.2E-07	9.7E-06	3.1E-05	5.0E-05
In-122	4.8E-08	1.3E-03	5.4E-03	1.1E-02	1.7E-02	3.0E-06	7.0E-05	2.2E-04	3.6E-04
Sn-122	NA	3.7E-04	1.1E-03	5.3E-03	9.2E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Rh-123	4.2E-09	8.5E-12	1.4E-11	0.0E+00	1.3E-12	2.3E-13	2.0E-12	0.0E+00	3.0E-13
Pd-123	9.5E-09	4.0E-07	4.8E-07	3.6E-08	5.7E-08	4.8E-09	3.1E-08	3.6E-09	5.9E-09
Ag-123	9.5E-09	2.8E-04	2.8E-04	4.8E-05	7.4E-05	3.3E-06	1.8E-05	4.8E-06	7.7E-06
Cd-123	6.7E-08	1.0E-02	1.5E-02	5.0E-03	8.4E-03	1.7E-05	1.4E-04	7.2E-05	1.3E-04
In-123m	1.5E-06	2.5E-04	3.9E-03	4.6E-03	6.9E-03	1.9E-08	1.6E-06	2.9E-06	4.6E-06

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
In-123	1.9E-07	3.9E-03	1.9E-02	1.9E-02	3.4E-02	2.4E-06	6.2E-05	9.8E-05	1.7E-04
Sn-123m	7.6E-05	3.1E-04	1.4E-03	4.2E-03	7.0E-03	4.7E-10	1.1E-08	5.3E-08	9.2E-08
Sn-123	3.5E-01	8.0E-04	4.0E-03	1.0E-02	2.0E-02	2.6E-13	6.9E-12	2.8E-11	5.6E-11
Sb-123	NA	5.2E-06	3.0E-05	4.6E-04	8.7E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Rh-124	---	1.0E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pd-124	1.6E-08	2.7E-07	2.3E-08	0.0E+00	0.0E+00	1.9E-09	8.8E-10	0.0E+00	0.0E+00
Ag-124	5.4E-09	5.5E-04	3.7E-05	6.2E-10	9.4E-10	1.2E-05	4.2E-06	1.1E-10	1.7E-10
Cd-124	3.9E-08	1.2E-02	8.9E-03	2.7E-04	4.3E-04	3.5E-05	1.4E-04	6.7E-06	1.1E-05
In-124	1.0E-07	3.4E-03	2.9E-02	3.5E-02	5.3E-02	3.9E-06	1.7E-04	3.3E-04	5.2E-04
Sn-124	NA	1.1E-02	2.6E-02	4.4E-02	6.8E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sb-124m	3.8E-05	2.4E-06	1.8E-04	5.0E-05	7.6E-05	7.2E-12	2.8E-09	1.2E-09	2.0E-09
Sb-124	1.6E-01	7.6E-06	1.8E-04	5.0E-05	7.6E-05	5.3E-15	6.5E-13	2.9E-13	4.6E-13
Ag-125	5.4E-09	1.7E-09	2.4E-09	5.0E-11	9.3E-11	3.5E-11	2.7E-10	8.8E-12	1.7E-11
Cd-125	2.2E-08	5.6E-03	5.2E-04	7.0E-05	1.3E-04	3.0E-05	1.5E-05	3.1E-06	5.8E-06
In-125m	3.9E-07	4.7E-03	1.8E-02	1.7E-02	2.7E-02	1.4E-06	2.9E-05	4.2E-05	7.0E-05
In-125	7.5E-08	4.7E-03	1.8E-02	1.7E-02	2.7E-02	7.2E-06	1.5E-04	2.2E-04	3.6E-04
Sn-125m	1.8E-05	1.1E-02	8.0E-03	2.2E-02	3.2E-02	6.7E-08	2.7E-07	1.2E-06	1.7E-06
Sn-125	2.6E-02	8.5E-03	2.3E-02	5.5E-02	9.1E-02	3.7E-11	5.3E-10	2.0E-09	3.4E-09
Sb-125	2.8E+00	2.7E-05	3.8E-05	6.6E-04	9.4E-04	1.1E-15	8.5E-15	2.3E-13	3.4E-13

[a] *The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Te-125m	1.6E-01	2.3E-11	4.1E-11	4.8E-09	6.2E-09	1.7E-20	1.6E-19	2.9E-17	3.9E-17
Ag-126	5.4E-09	4.8E-10	1.9E-10	3.9E-12	6.2E-12	1.0E-11	2.1E-11	6.9E-13	1.1E-12
Cd-126	1.6E-08	8.1E-03	1.9E-04	2.3E-05	3.4E-05	5.6E-05	7.2E-06	1.3E-06	2.1E-06
In-126	5.2E-08	3.3E-03	2.9E-02	2.9E-02	4.0E-02	7.3E-06	3.5E-04	5.4E-04	7.7E-04
Sn-126	2.3E+05	4.5E-02	6.8E-02	1.7E-01	2.2E-01	2.2E-17	1.8E-16	7.0E-16	9.6E-16
Sb-126m	3.5E-07	1.7E-03	1.1E-04	2.3E-03	2.0E-03	5.7E-07	1.9E-07	6.4E-06	5.6E-06
Sb-126	3.4E-02	6.5E-04	7.9E-05	1.4E-03	1.4E-03	2.2E-12	1.4E-12	3.9E-11	4.2E-11
Te-126	NA	8.3E-10	1.3E-09	1.4E-07	1.2E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ag-127	2.5E-09	1.6E-10	3.9E-11	0.0E+00	0.0E+00	7.2E-12	9.6E-12	0.0E+00	0.0E+00
Cd-127	1.3E-08	8.2E-03	1.1E-04	8.9E-06	9.3E-06	7.4E-05	5.1E-06	6.7E-07	7.3E-07
In-127m	1.2E-07	6.3E-03	3.3E-02	2.4E-02	2.1E-02	6.1E-06	1.7E-04	1.9E-04	1.7E-04
In-127	3.6E-08	4.1E-02	3.3E-02	2.4E-02	2.1E-02	1.3E-04	5.6E-04	6.4E-04	5.7E-04
Sn-127m	7.9E-06	7.9E-03	6.2E-02	1.3E-01	1.1E-01	1.2E-07	4.8E-06	1.5E-05	1.4E-05
Sn-127	2.4E-04	8.7E-02	1.8E-01	3.0E-01	3.2E-01	4.1E-08	4.5E-07	1.2E-06	1.3E-06
Sb-127	1.1E-02	7.1E-03	2.5E-03	2.8E-02	2.3E-02	7.7E-11	1.4E-10	2.5E-09	2.2E-09
Te-127m	3.0E-01	2.4E-08	3.1E-08	1.8E-06	1.7E-06	9.3E-18	6.4E-17	5.8E-15	5.6E-15
Te-127	1.1E-03	9.9E-09	1.1E-08	7.4E-07	5.9E-07	1.1E-15	6.3E-15	6.6E-13	5.5E-13
Pd-128	---	1.3E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ag-128	1.9E-09	1.1E-11	1.5E-12	0.0E+00	0.0E+00	6.8E-13	4.9E-13	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Cd-128	8.9E-09	3.6E-03	2.3E-05	4.0E-06	1.6E-06	4.6E-05	1.6E-06	4.3E-07	1.8E-07
In-128	2.5E-08	2.6E-02	3.9E-02	6.9E-02	2.3E-02	1.2E-04	9.5E-04	2.6E-03	9.0E-04
Sn-128	1.1E-04	3.0E-01	4.5E-01	5.5E-01	7.7E-01	3.1E-07	2.5E-06	4.6E-06	6.8E-06
Sb-128m	1.9E-05	6.4E-03	6.0E-03	5.7E-02	5.1E-02	3.8E-08	1.9E-07	2.9E-06	2.6E-06
Sb-128	1.0E-03	1.1E-02	4.4E-03	6.2E-02	3.7E-02	1.2E-09	2.6E-09	5.7E-08	3.5E-08
Te-128	NA	1.7E-04	9.5E-07	4.3E-05	3.9E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cd-129	8.6E-09	7.2E-07	3.8E-06	1.1E-07	1.9E-07	9.7E-09	2.7E-07	1.3E-08	2.2E-08
In-129m	3.9E-08	2.5E-02	1.7E-02	5.1E-03	6.4E-03	7.4E-05	2.6E-04	1.3E-04	1.6E-04
In-129	2.0E-08	2.8E-02	1.7E-02	5.1E-03	6.4E-03	1.6E-04	5.1E-04	2.5E-04	3.2E-04
Sn-129m	1.3E-05	2.0E-01	1.9E-01	2.9E-01	2.8E-01	1.7E-06	9.0E-06	2.1E-05	2.1E-05
Sn-129	4.6E-06	2.3E-01	5.5E-01	6.9E-01	8.0E-01	5.8E-06	7.4E-05	1.4E-04	1.7E-04
Sb-129	5.0E-04	6.4E-02	6.1E-02	3.8E-01	3.6E-01	1.5E-08	7.4E-08	7.3E-07	7.1E-07
Te-129m	9.2E-02	1.4E-05	1.2E-05	4.8E-04	3.9E-04	1.7E-14	7.9E-14	5.0E-12	4.2E-12
Te-129	1.3E-04	5.7E-06	4.1E-06	2.0E-04	1.4E-04	5.0E-12	1.9E-11	1.4E-09	1.0E-09
~~I-129~~	~~1.6E+07~~	~~0.0E+00~~	~~0.0E+00~~	~~3.9E-10~~	~~2.3E-10~~	~~0.0E+00~~	~~0.0E+00~~	~~2.3E-26~~	~~1.4E-26~~
Pd-130	---	6.8E-11	2.6E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ag-130	1.6E-09	6.7E-06	1.5E-07	1.7E-08	2.3E-08	4.8E-07	5.6E-08	1.0E-08	1.4E-08
Cd-130	5.1E-09	8.8E-02	1.1E-03	1.6E-04	2.0E-04	2.0E-03	1.4E-04	2.9E-05	3.9E-05
In-130	9.2E-09	9.4E-03	8.6E-02	3.3E-02	4.0E-02	1.2E-04	5.7E-03	3.5E-03	4.3E-03

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Sn-130	7.1E-06	1.1E+00	1.3E+00	9.4E-01	1.1E+00	1.8E-05	1.1E-04	1.3E-04	1.5E-04
Sb-130m	1.2E-05	3.6E-01	2.1E-01	5.9E-01	6.9E-01	3.4E-06	1.1E-05	4.7E-05	5.7E-05
Sb-130	7.5E-05	2.2E-01	1.5E-01	5.9E-01	4.4E-01	3.3E-07	1.2E-06	7.5E-06	5.9E-06
Te-130	NA	5.8E-02	2.4E-02	2.1E-01	2.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cd-131	2.2E-09	1.4E-02	9.8E-05	9.4E-06	1.2E-05	7.3E-04	2.8E-05	4.1E-06	5.3E-06
In-131	8.9E-09	1.1E-02	3.8E-02	8.4E-03	9.4E-03	1.4E-04	2.6E-03	9.0E-04	1.0E-03
Sn-131	1.8E-06	8.8E-01	1.4E+00	6.1E-01	6.9E-01	5.7E-05	4.8E-04	3.3E-04	3.8E-04
Sb-131	4.4E-05	1.7E+00	1.5E+00	1.9E+00	2.2E+00	4.3E-06	2.1E-05	4.2E-05	5.0E-05
Te-131m	3.7E-03	2.3E-01	2.2E-01	8.7E-01	7.1E-01	7.2E-09	3.7E-08	2.3E-07	1.9E-07
Te-131	4.8E-05	9.7E-02	7.5E-02	4.5E-01	2.5E-01	2.3E-07	9.8E-07	9.1E-06	5.2E-06
I-131	2.2E-02	3.9E-03	1.1E-03	2.3E-02	2.0E-02	2.0E-11	3.0E-11	1.0E-09	9.1E-10
Xe-133m	3.3E-02	3.5E-07	2.4E-07	3.0E-05	2.7E-05	1.2E-15	4.5E-15	8.8E-13	8.1E-13
Cd-132	3.2E-10	0.0E+00	1.6E-06	5.7E-07	3.0E-07	0.0E+00	3.1E-06	1.7E-06	9.4E-07
In-132	6.3E-09	6.2E-03	1.8E-03	1.6E-03	7.7E-04	1.1E-04	1.8E-04	2.4E-04	1.2E-04
Sn-132	1.3E-06	5.9E-01	3.2E-01	4.8E-01	2.3E-01	5.4E-05	1.6E-04	3.7E-04	1.8E-04
-m-132	5.3E-06	8.6E-01	1.5E+00	5.5E-01	9.1E-01	1.9E-05	1.8E-04	9.8E-05	1.7E-04
Sb-132	8.0E-06	1.3E+00	1.7E+00	1.9E+00	1.0E+00	1.9E-05	1.3E-04	2.2E-04	1.3E-04
Te-132	8.8E-03	1.5E+00	1.1E+00	2.3E+00	3.0E+00	2.0E-08	7.5E-08	2.5E-07	3.4E-07
I-132	2.6E-04	1.8E-02	1.0E-02	2.7E-01	1.7E-01	8.1E-09	2.4E-08	9.8E-07	6.6E-07

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Xe-132	NA	4.2E-05	1.7E-05	1.5E-03	1.4E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cs-132	1.8E-02	7.4E-08	2.6E-10	3.0E-07	2.6E-07	4.8E-16	9.1E-18	1.6E-14	1.5E-14
In-133	5.2E-09	1.7E-04	2.7E-04	3.8E-05	3.8E-05	3.8E-06	3.2E-05	7.0E-06	7.2E-06
Sn-133	4.6E-08	1.4E-01	1.4E-01	3.4E-02	3.6E-02	3.5E-04	1.9E-03	7.2E-04	7.8E-04
Sb-133	4.8E-06	2.3E+00	1.5E+00	1.2E+00	1.2E+00	5.5E-05	2.0E-04	2.4E-04	2.5E-04
Te-133m	1.1E-04	3.0E+00	2.1E+00	2.9E+00	3.2E+00	3.3E-06	1.2E-05	2.6E-05	3.0E-05
Te-133	2.4E-05	1.2E+00	2.6E+00	1.8E+00	1.2E+00	5.6E-06	6.8E-05	7.2E-05	5.2E-05
I-133	2.4E-03	1.7E-01	3.8E-01	1.1E+00	1.3E+00	8.0E-09	1.0E-07	4.5E-07	5.4E-07
Xe-133m	6.0E-03	1.9E-03	4.2E-03	3.4E-02	4.7E-02	3.6E-11	4.3E-10	5.4E-09	7.7E-09
Xe-133	1.4E-02	6.7E-04	1.5E-03	9.5E-03	1.6E-02	5.3E-12	6.3E-11	6.3E-10	1.1E-09
Cd-134	---	9.3E-11	3.0E-10	2.1E-11	1.8E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
In-134	4.4E-09	3.5E-06	6.0E-06	9.0E-07	7.2E-07	9.0E-08	8.3E-07	1.9E-07	1.6E-07
Sn-134	3.3E-08	1.8E-02	1.7E-02	3.8E-03	3.1E-03	6.2E-05	3.1E-04	1.1E-04	9.3E-05
Sb-134	2.5E-08	7.2E-01	4.9E-01	4.0E-01	3.1E-01	3.2E-03	1.2E-02	1.5E-02	1.2E-02
Te-134	8.0E-05	6.2E+00	6.0E+00	4.4E+00	4.5E+00	8.9E-06	4.6E-05	5.3E-05	5.6E-05
I-134m	7.0E-06	3.6E-01	3.4E-01	1.2E+00	1.2E+00	5.9E-06	3.0E-05	1.6E-04	1.6E-04
I-134	1.0E-04	5.0E-01	7.5E-01	1.4E+00	1.2E+00	5.7E-07	4.6E-06	1.4E-05	1.2E-05
Xe-134m	9.2E-09	2.5E-02	1.4E-02	1.7E-01	1.8E-01	3.1E-04	9.2E-04	1.8E-02	1.9E-02
Sn-135	1.7E-08	6.3E-04	1.6E-03	1.4E-04	1.3E-04	4.3E-06	5.9E-05	8.1E-06	7.4E-06

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Sb-135	5.4E-08	1.5E-01	2.5E-01	6.7E-02	5.3E-02	3.1E-04	2.8E-03	1.2E-03	9.7E-04
Te-135	6.0E-07	3.2E+00	2.5E+00	2.2E+00	2.1E+00	6.1E-04	2.5E-03	3.5E-03	3.5E-03
I-135	7.5E-04	2.9E+00	3.6E+00	4.3E+00	3.9E+00	4.5E-07	3.0E-06	5.5E-06	5.2E-06
Xe-135m	2.9E-05	1.8E-01	1.9E-01	7.5E-01	8.5E-01	7.0E-07	3.9E-06	2.5E-05	2.9E-05
Xe-135	1.0E-03	7.9E-02	1.2E-01	3.1E-01	6.1E-01	8.7E-09	7.1E-08	2.9E-07	5.9E-07
Cs-135	2.3E+06	4.9E-04	2.1E-04	1.3E-02	1.3E-02	2.4E-20	5.5E-20	5.2E-18	5.4E-18
In-136	---	1.7E-10	6.9E-10	2.8E-11	5.2E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sn-136	8.2E-09	1.6E-05	3.2E-05	1.9E-06	3.2E-06	2.2E-07	2.4E-06	2.2E-07	3.9E-07
Sb-136	2.9E-08	1.2E-02	1.4E-02	2.9E-03	4.2E-03	4.5E-05	3.0E-04	9.6E-05	1.4E-04
Te-136	5.5E-07	1.3E+00	1.0E+00	5.1E-01	6.8E-01	2.7E-04	1.1E-03	8.7E-04	1.2E-03
I-136m	1.5E-06	1.3E+00	1.5E+00	1.6E+00	1.6E+00	9.6E-05	6.0E-04	1.1E-03	1.1E-03
I-136	2.6E-06	1.3E+00	1.9E+00	1.3E+00	1.6E+00	5.7E-05	4.3E-04	4.5E-04	6.0E-04
Sn-137	7.6E-09	1.9E-05	3.7E-07	4.4E-08	4.9E-08	2.8E-07	3.0E-08	5.5E-09	6.4E-09
Sb-137	2.9E-08	7.4E-02	8.4E-04	2.8E-04	2.6E-04	3.0E-04	1.8E-05	9.2E-06	9.1E-06
Te-137	7.9E-08	3.9E-01	1.6E-01	1.3E-01	1.2E-01	5.7E-04	1.2E-03	1.6E-03	1.4E-03
I-137	7.8E-07	2.6E+00	2.4E+00	2.3E+00	1.9E+00	3.9E-04	1.9E-03	2.8E-03	2.4E-03
Xe-137	7.3E-06	3.2E+00	3.5E+00	3.7E+00	3.7E+00	5.0E-05	3.0E-04	4.8E-04	5.0E-04
Cs-137	3.0E+01	6.0E-02	2.3E-01	6.0E-01	1.0E+00	2.3E-13	4.7E-12	1.9E-11	3.3E-11
Ba-137m	4.9E-06	1.3E-04	6.3E-05	4.5E-03	4.1E-03	3.1E-09	8.0E-09	8.9E-07	8.3E-07

[a] *The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Sn-138	---	3.3E-09	1.8E-08	3.8E-10	9.7E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sb-138	5.5E-09	3.9E-05	1.1E-04	6.5E-06	1.5E-05	8.2E-07	1.3E-05	1.1E-06	2.7E-06
Te-138	4.4E-08	6.6E-02	1.1E-01	1.2E-02	2.5E-02	1.7E-04	1.5E-03	2.5E-04	5.6E-04
I-138	2.1E-07	1.4E+00	1.3E+00	1.3E+00	1.0E+00	7.9E-04	3.7E-03	5.9E-03	4.9E-03
Xe-138	2.7E-05	4.8E+00	4.7E+00	3.9E+00	3.7E+00	2.1E-05	1.1E-04	1.4E-04	1.4E-04
Cs-138m	5.5E-06	2.2E-01	1.2E-01	5.9E-01	6.8E-01	4.6E-06	1.3E-05	1.0E-04	1.2E-04
Cs-138	6.1E-05	2.4E-01	5.5E-01	3.1E-01	6.8E-01	4.6E-07	5.6E-06	4.8E-06	1.1E-05
Sb-139	6.9E-09	1.4E-06	3.9E-06	1.7E-07	2.8E-07	2.3E-08	3.5E-07	2.4E-08	4.1E-08
Te-139	1.8E-08	6.7E-03	9.8E-03	8.1E-04	1.3E-03	4.2E-05	3.3E-04	4.2E-05	7.0E-05
I-139	7.3E-08	7.7E-01	4.6E-01	3.2E-01	1.9E-01	1.2E-03	3.9E-03	4.2E-03	2.6E-03
Xe-139	1.3E-06	4.3E+00	3.8E+00	2.8E+00	2.9E+00	3.9E-04	1.9E-03	2.1E-03	2.3E-03
Cs-139	1.8E-05	1.3E+00	2.1E+00	2.3E+00	2.3E+00	8.5E-06	7.3E-05	1.3E-04	1.3E-04
Ba-139	1.6E-04	6.9E-02	2.0E-02	2.3E-01	2.4E-01	5.0E-08	7.8E-08	1.4E-06	1.5E-06
La-139	NA	2.3E-05	8.9E-06	1.0E-03	9.5E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ce-139m	1.8E-06	7.0E-10	2.3E-10	2.4E-07	2.4E-07	4.5E-14	7.7E-14	1.3E-10	1.3E-10
Te-140	2.8E-08	1.7E-02	9.0E-04	1.4E-04	8.1E-05	6.8E-05	2.0E-05	4.8E-06	2.8E-06
I-140	2.7E-08	1.4E-01	1.1E-01	5.9E-02	3.2E-02	5.8E-04	2.5E-03	2.1E-03	1.2E-03
Xe-140	4.3E-07	3.5E+00	2.6E+00	1.5E+00	1.6E+00	9.3E-04	3.7E-03	3.4E-03	3.7E-03
Cs-140	2.0E-06	2.1E+00	3.1E+00	2.3E+00	2.8E+00	1.2E-04	9.3E-04	1.1E-03	1.4E-03

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ba-140	3.5E-02	4.9E-01	2.4E-01	1.5E+00	9.2E-01	1.6E-09	4.2E-09	4.1E-08	2.6E-08
La-140	4.6E-03	5.2E-03	2.0E-04	1.0E-02	9.9E-03	1.3E-10	2.7E-11	2.1E-09	2.1E-09
I-141	1.4E-08	4.1E-02	1.7E-02	7.0E-03	3.6E-03	3.3E-04	7.3E-04	4.7E-04	2.5E-04
Xe-141	5.5E-08	1.2E+00	8.8E-01	4.7E-01	4.8E-01	2.6E-03	9.9E-03	8.3E-03	8.7E-03
Cs-141	7.9E-07	2.9E+00	3.5E+00	2.9E+00	2.6E+00	4.2E-04	2.7E-03	3.5E-03	3.3E-03
Ba-141	3.5E-05	1.7E+00	1.6E+00	1.8E+00	2.0E+00	5.5E-06	2.8E-05	5.0E-05	5.6E-05
La-141	4.5E-04	1.9E-02	4.7E-03	7.2E-02	6.9E-02	4.8E-09	6.4E-09	1.5E-07	1.5E-07
Ce-141	8.9E-02	5.0E-06	3.2E-05	2.3E-04	2.5E-04	6.4E-15	2.2E-13	2.5E-12	2.7E-12
Te-142	1.9E-08	2.1E-06	1.4E-06	5.7E-07	4.6E-08	1.3E-08	4.6E-08	2.9E-08	2.4E-09
I-142	6.3E-09	5.9E-03	2.3E-03	2.5E-03	2.0E-04	1.1E-04	2.2E-04	3.7E-04	3.1E-05
Xe-142	3.9E-08	4.3E-01	5.7E-01	1.4E-01	9.7E-02	1.3E-03	9.0E-03	3.5E-03	2.5E-03
Cs-142	5.7E-08	2.3E+00	2.3E+00	1.4E+00	1.3E+00	4.6E-03	2.4E-02	2.3E-02	2.2E-02
Ba-142	2.0E-05	3.0E+00	2.7E+00	3.1E+00	3.1E+00	1.7E-05	8.0E-05	1.4E-04	1.5E-04
La-142	1.8E-04	9.7E-02	3.0E-02	3.0E-01	2.7E-01	6.3E-08	1.0E-07	1.6E-06	1.5E-06
Ce-142	5.0E+16	1.8E-04	7.1E-05	3.6E-03	3.7E-03	4.0E-31	8.8E-31	6.8E-29	7.3E-29
Xe-143	9.5E-09	5.3E-02	6.4E-02	1.2E-02	1.2E-02	6.4E-04	4.1E-03	1.2E-03	1.2E-03
Cs-143	5.6E-08	1.4E+00	1.2E+00	6.8E-01	5.5E-01	2.8E-03	1.3E-02	1.2E-02	9.6E-03
Ba-143	4.5E-07	4.1E+00	3.6E+00	2.9E+00	2.9E+00	1.0E-03	4.9E-03	6.1E-03	6.4E-03
La-143	2.7E-05	3.8E-01	8.7E-01	8.2E-01	8.4E-01	1.6E-06	2.0E-05	2.9E-05	3.1E-05

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ce-143	3.8E-03	3.1E-02	1.4E-03	2.7E-02	2.9E-02	9.5E-10	2.3E-10	6.8E-09	7.6E-09
Pr-143	3.7E-02	4.5E-07	1.6E-07	3.4E-05	3.6E-05	1.4E-15	2.7E-15	8.6E-13	9.5E-13
Nd-143	NA	4.8E-12	1.4E-12	2.9E-09	3.5E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Xe-144	3.8E-08	6.1E-03	0.0E+00	7.4E-04	9.1E-04	1.8E-05	0.0E+00	1.9E-05	2.4E-05
Cs-144	3.2E-08	4.2E-01	3.8E-01	1.6E-01	1.1E-01	1.5E-03	7.3E-03	4.7E-03	3.5E-03
Ba-144	3.6E-07	4.0E+00	3.0E+00	2.2E+00	2.0E+00	1.3E-03	5.1E-03	5.7E-03	5.6E-03
La-144	1.3E-06	1.1E+00	1.9E+00	1.3E+00	1.4E+00	9.5E-05	8.8E-04	9.7E-04	1.0E-03
Ce-144	7.8E-01	3.5E-02	1.7E-02	1.2E-01	1.6E-01	5.1E-12	1.3E-11	1.4E-10	2.1E-10
Pr-144m	1.4E-05	1.3E-05	4.9E-06	3.3E-04	5.2E-04	1.1E-10	2.2E-10	2.3E-08	3.7E-08
Pr-144	3.3E-05	1.4E-06	4.8E-07	3.7E-05	5.1E-05	5.0E-12	9.0E-12	1.1E-09	1.5E-09
Nd-144	2.38E15	9.6E-09	1.3E-08	1.4E-07	5.7E-08	4.6E-34	3.3E-33	5.5E-32	2.4E-32
Xe-145	2.9E-08	7.2E-05	8.5E-04	5.7E-05	3.6E-05	2.9E-07	1.8E-05	1.9E-06	1.2E-06
Cs-145	1.9E-08	7.6E-02	1.4E-01	2.8E-02	1.8E-02	4.6E-04	4.5E-03	1.4E-03	9.3E-04
Ba-145	1.3E-07	1.9E+00	2.3E+00	8.0E-01	8.0E-01	1.7E-03	1.1E-02	6.1E-03	6.3E-03
La-145	7.6E-07	1.9E+00	1.2E+00	1.7E+00	1.7E+00	2.9E-04	1.0E-03	2.1E-03	2.2E-03
Ce-145	5.7E-06	8.5E-02	9.2E-02	4.6E-01	5.0E-01	1.7E-06	9.9E-06	7.6E-05	8.7E-05
Pr-145	6.8E-04	3.3E-04	1.5E-04	5.8E-03	6.5E-03	5.6E-11	1.3E-10	8.1E-09	9.4E-09
Nd-145	NA	5.6E-08	1.8E-08	5.9E-06	7.5E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pm-145	1.8E+01	0.0E+00	0.0E+00	2.0E-10	2.7E-10	0.0E+00	0.0E+00	1.1E-20	1.5E-20

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions) U-235 Thermal Neutrons	Fission Yields U-235 Fast Neutrons	Fission Yields Pu-239 Thermal Neutrons	Fission Yields Pu-239 Fast Neutrons	Fractional Abundance (activity basis) U-235 Thermal Neutrons	Fractional Abundance U-235 Fast Neutrons	Fractional Abundance Pu-239 Thermal Neutrons	Fractional Abundance Pu-239 Fast Neutrons
Xe-146	1.8E-08	1.1E-05	3.4E-05	1.5E-06	9.5E-07	6.8E-08	1.2E-06	8.2E-08	5.3E-08
Cs-146	1.0E-08	7.6E-03	1.5E-02	2.1E-03	1.3E-03	8.6E-05	9.2E-04	2.0E-04	1.3E-04
Ba-146	7.0E-08	9.1E-01	1.2E+00	2.4E-01	2.2E-01	1.5E-03	1.0E-02	3.3E-03	3.2E-03
La-146	2.0E-07	1.5E+00	1.3E+00	1.2E+00	1.1E+00	8.6E-04	4.1E-03	5.6E-03	5.6E-03
Ce-146	2.6E-05	5.8E-01	4.3E-01	1.0E+00	1.1E+00	2.6E-06	1.0E-05	3.9E-05	4.2E-05
Pr-146	4.6E-05	3.6E-03	1.8E-03	2.0E-02	3.6E-02	9.0E-09	2.4E-08	4.1E-07	7.8E-07
Nd-146	NA	3.2E-06	1.2E-06	8.1E-05	1.7E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pm-146	5.5E+00	4.5E-10	7.2E-12	7.9E-09	1.7E-08	9.3E-21	8.0E-22	1.4E-18	3.1E-18
Ba-147	2.8E-08	2.5E-01	2.4E-01	3.5E-02	3.4E-02	1.0E-03	5.3E-03	1.2E-03	1.2E-03
La-147	1.3E-07	6.4E-01	1.1E+00	6.1E-01	5.8E-01	5.8E-04	5.4E-03	4.6E-03	4.5E-03
Ce-147	1.8E-06	1.0E+00	7.7E-01	1.2E+00	1.2E+00	6.4E-05	2.7E-04	6.6E-04	6.9E-04
Pr-147	2.5E-05	3.6E-01	1.5E-02	1.4E-01	1.4E-01	1.6E-06	3.7E-07	5.2E-06	5.5E-06
Nd-147	3.0E-02	6.7E-05	2.8E-05	1.6E-03	1.7E-03	2.6E-13	5.7E-13	5.1E-11	5.7E-11
Pm-147	2.6E+00	2.5E-09	8.6E-10	6.5E-07	7.0E-07	1.1E-19	2.0E-19	2.4E-16	2.7E-16
Sm-147	1.1E+11	0.0E+00	0.0E+00	1.8E-11	2.3E-11	0.0E+00	0.0E+00	1.7E-31	2.1E-31
Xe-148	---	1.1E-09	6.2E-09	9.1E-11	1.5E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Cs-148	4.8E-09	1.3E-05	4.1E-05	1.5E-06	2.3E-06	3.2E-07	5.3E-06	3.0E-07	4.8E-07
Ba-148	2.0E-08	2.2E-02	3.9E-02	2.6E-03	4.0E-03	1.3E-04	1.2E-03	1.2E-04	2.0E-04
La-148	3.5E-08	3.4E-01	4.2E-01	1.2E-01	1.7E-01	1.1E-03	7.4E-03	3.2E-03	4.9E-03

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).
NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable
--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ce-148	1.8E-06	1.2E+00	1.2E+00	8.9E-01	1.2E+00	8.0E-05	4.0E-04	4.8E-04	6.5E-04
Pr-148	4.3E-06	7.8E-02	5.6E-02	6.2E-01	3.1E-01	2.1E-06	8.0E-06	1.4E-04	7.0E-05
Nd-148	NA	9.9E-04	5.2E-04	1.4E-02	1.4E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ba-149	1.1E-08	1.0E-03	2.6E-03	2.2E-04	2.4E-04	1.1E-05	1.5E-04	1.9E-05	2.2E-05
La-149	3.3E-08	8.0E-02	1.3E-01	3.6E-02	3.9E-02	2.8E-04	2.3E-03	1.0E-03	1.2E-03
Ce-149	1.6E-07	7.0E-01	7.6E-01	5.6E-01	6.4E-01	4.9E-04	2.8E-03	3.3E-03	3.9E-03
Pr-149	4.4E-06	3.0E-01	1.5E-01	5.7E-01	5.0E-01	7.8E-06	2.1E-05	1.2E-04	1.1E-04
Nd-149	2.0E-04	6.8E-03	3.5E-03	5.0E-02	6.0E-02	4.0E-09	1.1E-08	2.4E-07	3.0E-07
Pm-149	6.1E-03	3.9E-06	1.6E-06	2.4E-04	2.5E-04	7.3E-14	1.7E-13	3.8E-11	4.1E-11
Sm-149	1.0E+16	1.7E-10	5.7E-11	8.2E-08	9.4E-08	2.0E-36	3.5E-36	7.8E-33	9.4E-33
Cs-150	3.9E-09	2.0E-09	1.1E-08	6.3E-10	5.6E-10	5.8E-11	1.8E-09	1.5E-10	1.4E-10
Ba-150	9.5E-09	5.0E-05	1.5E-04	1.2E-05	1.1E-05	6.1E-07	9.6E-06	1.2E-06	1.2E-06
La-150	1.6E-08	1.0E-02	1.9E-02	5.2E-03	4.9E-03	7.4E-05	7.2E-04	3.1E-04	3.0E-04
Ce-150	1.4E-07	3.9E-01	4.6E-01	2.8E-01	2.8E-01	3.2E-04	2.0E-03	1.9E-03	2.0E-03
Pr-150	2.0E-07	2.2E-01	1.9E-01	5.1E-01	5.2E-01	1.3E-04	5.9E-04	2.5E-03	2.6E-03
Nd-150	NA	3.3E-02	2.0E-02	1.7E-01	1.9E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pm-150	3.1E-04	3.0E-05	2.5E-05	1.2E-03	2.2E-03	1.1E-11	5.0E-11	3.6E-09	7.2E-09
Sm-150	NA	1.2E-08	4.6E-09	2.5E-06	3.2E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
La-151	2.3E-08	1.0E-03	2.4E-03	4.8E-04	4.2E-04	5.2E-06	6.4E-05	2.0E-05	1.8E-05

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ce-151	3.2E-08	9.9E-02	1.4E-01	6.3E-02	6.2E-02	3.6E-04	2.7E-03	1.9E-03	1.9E-03
Pr-151	6.0E-07	2.4E-01	2.2E-01	3.7E-01	3.7E-01	4.6E-05	2.2E-04	5.9E-04	6.2E-04
Nd-151	2.4E-05	8.0E-02	5.4E-02	2.9E-01	3.4E-01	3.9E-07	1.4E-06	1.2E-05	1.4E-05
Pm-151	3.2E-03	6.4E-04	3.2E-04	1.1E-02	1.3E-02	2.3E-11	6.1E-11	3.2E-09	3.9E-09
Sm-151	9.0E+01	4.8E-07	1.6E-07	3.9E-05	5.4E-05	6.1E-19	1.1E-18	4.1E-16	5.9E-16
Eu-151	NA	2.5E-10	9.6E-10	4.6E-09	6.8E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ba-152	1.3E-08	1.5E-08	8.2E-08	5.4E-09	4.1E-09	1.3E-10	3.8E-09	3.9E-10	3.1E-10
La-152	9.0E-09	4.5E-05	1.4E-04	2.4E-05	2.0E-05	5.8E-07	9.3E-06	2.6E-06	2.2E-06
Ce-152	4.4E-08	2.1E-02	3.5E-02	1.2E-02	1.1E-02	5.3E-05	4.9E-04	2.5E-04	2.4E-04
Pr-152	1.0E-07	1.0E-01	1.2E-01	1.6E-01	1.6E-01	1.2E-04	7.3E-04	1.5E-03	1.6E-03
Nd-152	2.2E-05	1.4E-01	1.1E-01	3.7E-01	4.1E-01	7.5E-07	3.2E-06	1.6E-05	1.9E-05
Pm-152m	2.6E-05	1.4E-03	8.3E-04	1.7E-02	2.0E-02	6.1E-09	1.9E-08	6.1E-07	7.7E-07
Pm-152	7.8E-06	1.4E-03	8.3E-04	1.7E-02	2.0E-02	2.0E-08	6.5E-08	2.0E-06	2.6E-06
Sm-152	NA	9.7E-06	4.1E-06	4.3E-04	6.1E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Eu-152m	1.8E-04	1.4E-10	4.7E-11	6.8E-08	1.1E-07	8.5E-17	1.6E-16	3.6E-13	5.9E-13
La-153	1.0E-08	1.4E-06	6.0E-06	8.5E-07	6.3E-07	1.6E-08	3.5E-07	7.9E-08	6.1E-08
Ce-153	4.7E-08	1.7E-03	3.9E-03	1.1E-03	9.6E-04	4.2E-06	5.2E-05	2.2E-05	2.0E-05
Pr-153	1.4E-07	3.7E-02	5.5E-02	4.9E-02	5.0E-02	3.1E-05	2.5E-04	3.5E-04	3.6E-04
Nd-153	1.0E-06	1.1E-01	1.0E-01	2.4E-01	2.8E-01	1.3E-05	6.2E-05	2.3E-04	2.7E-04

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Pm-153	1.0E-05	8.8E-03	6.5E-03	6.8E-02	9.3E-02	9.8E-08	3.9E-07	6.4E-06	8.9E-06
Sm-153	5.3E-03	8.0E-05	4.2E-05	2.1E-03	3.6E-03	1.7E-12	4.9E-12	3.8E-10	6.7E-10
Eu-153	NA	2.3E-07	4.6E-09	2.5E-06	4.5E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Gd-153	6.6E-01	0.0E+00	0.0E+00	2.2E-10	5.0E-10	0.0E+00	0.0E+00	3.1E-19	7.5E-19
Ba-154	---	0.0E+00	3.7E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
La-154	4.7E-09	1.5E-08	8.0E-08	1.8E-08	1.0E-08	3.5E-10	1.0E-08	3.7E-09	2.1E-09
Ce-154	6.4E-08	9.1E-05	2.5E-04	8.6E-05	5.8E-05	1.6E-07	2.4E-06	1.3E-06	9.0E-07
Pr-154	7.3E-08	5.0E-03	7.9E-03	9.7E-03	7.7E-03	7.9E-06	6.7E-05	1.3E-04	1.1E-04
Nd-154	8.2E-07	5.8E-02	5.7E-02	1.5E-01	1.5E-01	8.1E-06	4.2E-05	1.8E-04	1.8E-04
Pm-154m	5.1E-06	5.4E-03	3.7E-03	4.5E-02	5.0E-02	1.2E-07	4.4E-07	8.4E-06	9.7E-06
Pm-154	3.2E-06	5.4E-03	3.7E-03	4.5E-02	5.0E-02	1.9E-07	7.0E-07	1.3E-05	1.5E-05
Sm-154	NA	4.7E-04	2.1E-04	9.4E-03	1.3E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Eu-154	8.6E+00	1.9E-07	6.2E-08	2.8E-05	4.7E-05	2.6E-18	4.4E-18	3.1E-15	5.5E-15
Ce-155	1.7E-08	2.6E-06	1.2E-05	3.5E-06	2.5E-06	1.7E-08	4.3E-07	2.0E-07	1.5E-07
Pr-155	3.6E-08	6.7E-04	1.7E-03	1.4E-03	1.2E-03	2.2E-06	2.9E-05	3.9E-05	3.4E-05
Nd-155	2.8E-07	1.8E-02	2.5E-02	5.1E-02	5.6E-02	7.1E-06	5.5E-05	1.7E-04	2.0E-04
Pm-155	1.3E-06	1.3E-02	1.2E-02	9.2E-02	1.2E-01	1.1E-06	5.5E-06	6.6E-05	8.7E-05
Sm-155	4.2E-05	1.3E-03	7.9E-04	2.1E-02	3.5E-02	3.6E-09	1.2E-08	4.8E-07	8.2E-07
Eu-155	4.8E+00	2.6E-06	1.1E-06	1.9E-04	4.5E-04	6.4E-17	1.4E-16	3.9E-14	9.4E-14

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).
NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable
--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Gd-155	NA	4.1E-10	1.3E-10	1.7E-07	5.2E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-155	1.5E-02	0.0E+00	0.0E+00	4.7E-12	1.9E-11	0.0E+00	0.0E+00	3.1E-19	1.3E-18
Ce-156	1.9E-08	5.7E-08	4.2E-07	1.2E-07	7.9E-08	3.5E-10	1.4E-08	6.2E-09	4.1E-09
Pr-156	1.2E-08	4.1E-05	1.5E-04	1.3E-04	1.0E-04	3.9E-07	7.6E-06	1.0E-05	8.3E-06
Nd-156	1.7E-07	4.7E-03	9.1E-03	1.6E-02	1.6E-02	3.1E-06	3.2E-05	8.8E-05	8.9E-05
Pm-156	8.5E-07	7.1E-03	8.7E-03	6.2E-02	7.3E-02	9.6E-07	6.3E-06	7.0E-05	8.5E-05
Sm-156	1.1E-03	3.0E-03	2.3E-03	4.5E-02	6.5E-02	3.2E-10	1.3E-09	4.0E-08	6.0E-08
Eu-156	4.2E-02	1.6E-05	8.3E-06	1.2E-03	2.0E-03	4.5E-14	1.2E-13	2.7E-11	4.8E-11
Gd-156	NA	1.4E-08	3.9E-09	3.9E-06	1.3E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-156m	6.1E-04	0.0E+00	0.0E+00	2.9E-11	7.7E-11	0.0E+00	0.0E+00	4.6E-17	1.3E-16
Tb-156	1.5E-02	0.0E+00	0.0E+00	2.6E-10	7.7E-10	0.0E+00	0.0E+00	1.7E-17	5.3E-17
Ce-157	6.8E-09	4.6E-10	6.6E-09	1.8E-09	1.2E-09	7.8E-12	6.0E-10	2.5E-10	1.8E-10
Pr-157	1.2E-08	1.7E-06	1.1E-05	7.2E-06	5.8E-06	1.6E-08	5.7E-07	5.7E-07	4.8E-07
Nd-157	7.9E-08	4.9E-04	1.6E-03	2.2E-03	2.3E-03	7.1E-07	1.3E-05	2.7E-05	2.9E-05
Pm-157	3.5E-07	2.9E-03	5.8E-03	2.7E-02	3.4E-02	9.7E-07	1.0E-05	7.6E-05	9.7E-05
Sm-157	1.5E-05	2.7E-03	3.2E-03	4.1E-02	6.4E-02	2.0E-08	1.3E-07	2.6E-06	4.2E-06
Eu-157	1.7E-03	6.4E-05	4.7E-05	3.5E-03	6.4E-03	4.2E-12	1.7E-11	1.9E-09	3.6E-09
Gd-157	NA	1.5E-07	6.5E-08	2.9E-05	6.9E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-157	7.0E+01	4.9E-12	1.5E-12	8.2E-09	2.4E-08	8.1E-24	1.3E-23	1.1E-19	3.4E-19

[a] *The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide: the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Ce-158	---	3.9E-12	9.3E-11	1.9E-11	1.3E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pr-158	5.4E-09	3.8E-08	4.0E-07	2.0E-07	1.7E-07	8.0E-10	4.6E-08	3.5E-08	3.1E-08
Nd-158	8.5E-08	5.2E-05	2.6E-04	2.2E-04	2.3E-04	7.0E-08	1.9E-06	2.5E-06	2.7E-06
Pm-158	1.6E-07	7.1E-04	2.0E-03	6.4E-03	8.2E-03	5.1E-07	7.8E-06	3.9E-05	5.1E-05
Sm-158	1.0E-05	2.4E-03	4.1E-03	2.9E-02	4.7E-02	2.7E-08	2.5E-07	2.8E-06	4.6E-06
Eu-158	8.7E-05	1.3E-04	1.4E-04	5.4E-03	1.0E-02	1.7E-10	9.8E-10	5.9E-08	1.2E-07
Gd-158	NA	1.5E-06	8.8E-07	1.5E-04	3.7E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-158m	3.3E-07	1.3E-11	4.8E-12	1.1E-08	3.1E-08	4.6E-15	8.8E-15	3.2E-11	9.3E-11
Tb-158	1.8E+02	1.2E-10	4.8E-11	1.0E-07	3.1E-07	7.6E-23	1.7E-22	5.3E-19	1.7E-18
Pr-159	5.7E-09	4.9E-10	1.0E-08	4.1E-09	3.8E-09	9.8E-12	1.1E-09	6.9E-10	6.5E-10
Nd-159	2.0E-08	1.8E-06	1.7E-05	1.2E-05	1.4E-05	1.0E-08	5.0E-07	5.6E-07	6.8E-07
Pm-159	6.3E-08	1.1E-04	5.3E-04	1.2E-03	1.7E-03	1.9E-07	5.2E-06	1.8E-05	2.7E-05
Sm-159	3.6E-07	7.4E-04	2.2E-03	1.2E-02	2.2E-02	2.4E-07	3.7E-06	3.2E-05	5.9E-05
Eu-159	3.4E-05	1.6E-04	2.9E-04	6.8E-03	1.4E-02	5.2E-10	5.2E-09	1.9E-07	4.1E-07
Gd-159	2.1E-03	3.7E-06	4.5E-06	4.5E-04	1.2E-03	2.0E-13	1.3E-12	2.1E-10	5.7E-10
Tb-159	NA	1.7E-09	1.3E-09	1.3E-06	4.0E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dy-159	4.0E-01	0.0E+00	0.0E+00	2.6E-10	1.1E-09	0.0E+00	0.0E+00	6.3E-19	2.8E-18
Pr-160	---	2.8E-12	9.1E-11	4.8E-11	3.3E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nd-160	2.5E-08	5.0E-08	7.1E-07	5.1E-07	4.5E-07	2.3E-10	1.7E-08	1.9E-08	1.8E-08

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Pm-160	2.3E-08	7.6E-06	5.4E-05	1.3E-04	1.4E-04	3.7E-08	1.4E-06	5.2E-06	6.0E-06
Sm-160	3.0E-07	2.1E-04	8.3E-04	4.0E-03	5.7E-03	8.0E-08	1.7E-06	1.3E-05	1.9E-05
Eu-160	1.2E-06	9.0E-05	2.3E-04	4.6E-03	8.0E-03	8.6E-09	1.2E-07	3.6E-06	6.6E-06
Gd-160	NA	1.0E-05	1.5E-05	9.7E-04	2.2E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-160	2.0E-01	2.8E-08	1.1E-08	6.3E-06	1.8E-05	1.6E-17	3.5E-17	3.0E-14	9.1E-14
Dy-160	NA	1.9E-12	1.2E-12	4.7E-09	1.8E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Nd-161	9.9E-09	6.2E-10	1.3E-08	1.1E-08	9.9E-09	7.2E-12	8.1E-10	1.1E-09	1.0E-09
Pm-161	2.5E-08	4.4E-07	4.5E-06	1.0E-05	1.1E-05	2.0E-09	1.1E-07	4.0E-07	4.4E-07
Sm-161	1.6E-07	2.8E-05	1.5E-04	7.8E-04	1.1E-03	2.0E-08	5.9E-07	4.7E-06	7.0E-06
Eu-161	8.2E-07	4.5E-05	1.5E-04	2.8E-03	4.7E-03	6.3E-09	1.1E-07	3.2E-06	5.6E-06
Gd-161	7.0E-06	1.1E-05	2.3E-05	1.3E-03	2.8E-03	1.8E-10	2.0E-09	1.7E-07	4.0E-07
Tb-161	1.9E-02	6.0E-08	7.7E-08	2.9E-05	7.8E-05	3.6E-16	2.5E-15	1.4E-12	4.1E-12
Dy-161	NA	2.5E-11	2.2E-11	5.5E-08	2.8E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-161m	2.2E-07	0.0E+00	0.0E+00	0.0E+00	2.8E-12	0.0E+00	0.0E+00	0.0E+00	1.3E-14
Ho-161	2.8E-04	0.0E+00	0.0E+00	3.1E-12	2.0E-11	0.0E+00	0.0E+00	1.0E-17	7.1E-17
Nd-162	---	3.5E-12	1.1E-10	1.8E-10	2.1E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pm-162	1.0E-08	6.8E-09	9.6E-08	4.2E-07	6.2E-07	7.6E-11	5.8E-09	3.9E-08	6.0E-08
Sm-162	1.7E-07	2.0E-06	1.4E-05	1.1E-04	2.2E-04	1.4E-09	5.1E-08	6.4E-07	1.3E-06
Eu-162	3.5E-07	7.0E-06	2.8E-05	8.6E-04	2.1E-03	2.3E-09	4.9E-08	2.4E-06	5.9E-06

[a] *The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

NA = *Not applicable: no half-life or fractional abundances are provided because the isotope is stable*

--- = *No half-life was found for the radionuclide; the isotope was not included in the fission product allocation*

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Gd-162	1.6E-05	6.8E-06	1.6E-05	1.2E-03	3.6E-03	4.9E-11	6.1E-10	7.1E-08	2.3E-07
Tb-162m	2.5E-04	4.5E-08	6.5E-08	3.1E-05	1.2E-04	2.0E-14	1.6E-13	1.2E-10	4.6E-10
Tb-162	1.4E-05	4.5E-08	6.5E-08	3.1E-05	1.2E-04	3.6E-13	2.8E-12	2.1E-09	8.1E-09
Dy-162	NA	2.0E-10	1.7E-10	4.4E-07	2.2E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-162m	1.3E-04	0.0E+00	0.0E+00	5.2E-11	3.6E-10	0.0E+00	0.0E+00	3.9E-16	2.8E-15
Nd-163	---	0.0E+00	0.0E+00	1.3E-12	1.6E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Pm-163	---	1.8E-10	1.6E-09	1.2E-08	1.9E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sm-163	4.0E-08	1.4E-07	5.5E-07	8.0E-06	1.7E-05	3.9E-10	8.4E-09	1.9E-07	4.2E-07
Eu-163	2.4E-07	1.9E-06	4.2E-06	2.1E-04	5.5E-04	9.2E-10	1.1E-08	8.2E-07	2.3E-06
Gd-163	2.1E-06	3.8E-06	4.7E-06	6.0E-04	2.1E-03	2.0E-10	1.3E-09	2.7E-07	9.8E-07
Tb-163	3.7E-05	2.1E-07	1.6E-07	1.0E-04	4.4E-04	6.6E-13	2.6E-12	2.6E-09	1.2E-08
Dy-163	NA	1.2E-09	5.2E-10	1.7E-06	1.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-163m	3.5E-08	0.0E+00	0.0E+00	1.4E-10	1.1E-09	0.0E+00	0.0E+00	4.0E-12	3.1E-11
Ho-163	4.6E+03	0.0E+00	0.0E+00	9.6E-10	7.8E-09	0.0E+00	0.0E+00	2.0E-22	1.7E-21
Pm-164	---	1.7E-12	4.0E-11	1.7E-10	3.6E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sm-164	4.4E-08	6.0E-09	6.2E-08	4.2E-07	1.2E-06	1.6E-11	8.7E-10	9.1E-09	2.7E-08
Eu-164	5.0E-08	2.0E-07	1.1E-06	2.5E-05	9.7E-05	4.6E-10	1.3E-08	4.8E-07	1.9E-06
Gd-164	1.4E-06	1.5E-06	4.3E-06	2.2E-04	1.1E-03	1.2E-10	1.9E-09	1.5E-07	7.9E-07
Tb-164	5.7E-06	1.8E-07	3.2E-07	7.8E-05	5.1E-04	3.6E-12	3.4E-11	1.3E-08	8.9E-08

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Dy-164	NA	4.8E-09	4.7E-09	4.5E-06	4.1E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-164m	7.2E-05	0.0E+00	0.0E+00	4.9E-09	6.5E-08	0.0E+00	0.0E+00	6.5E-14	8.9E-13
Ho-164	5.5E-05	0.0E+00	0.0E+00	2.1E-09	2.4E-08	0.0E+00	0.0E+00	3.7E-14	4.3E-13
Pm-165	---	0.0E+00	0.0E+00	2.2E-12	5.1E-12	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sm-165	1.4E-08	2.6E-10	2.7E-09	1.4E-08	4.5E-08	2.0E-12	1.1E-10	9.3E-10	3.1E-09
Eu-165	4.3E-08	3.9E-08	2.0E-07	3.0E-06	1.3E-05	1.0E-10	2.8E-09	6.8E-08	2.9E-07
Gd-165	3.2E-07	6.1E-07	1.6E-06	6.0E-05	3.4E-04	2.2E-10	3.2E-09	1.8E-07	1.1E-06
Tb-165	4.0E-06	2.8E-07	4.5E-07	6.3E-05	4.6E-04	8.1E-12	7.0E-11	1.5E-08	1.1E-07
Dy-165m	2.4E-06	2.3E-09	1.9E-09	1.1E-06	1.0E-05	1.1E-13	5.0E-13	4.3E-10	4.1E-09
Dy-165	2.7E-04	1.5E-08	1.4E-08	7.2E-06	7.4E-05	6.6E-15	3.3E-14	2.6E-11	2.7E-10
Ho-165	NA	2.1E-11	1.1E-11	4.8E-08	6.4E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Er-165	1.2E-03	0.0E+00	0.0E+00	2.1E-11	4.2E-10	0.0E+00	0.0E+00	1.7E-17	3.5E-16
Sm-166	---	6.4E-12	9.6E-11	4.4E-10	1.7E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Eu-166	---	2.5E-09	1.7E-08	2.4E-07	1.3E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Gd-166	---	1.7E-07	5.8E-07	1.6E-05	1.2E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-166	6.3E-07	1.5E-07	3.2E-07	3.6E-05	3.3E-04	2.8E-11	3.1E-10	5.4E-08	5.2E-07
Dy-166	9.3E-03	4.0E-08	4.7E-08	1.5E-05	1.9E-04	4.9E-16	3.1E-15	1.5E-12	2.0E-11
Ho-166m	1.2E+03	9.4E-11	6.0E-11	1.3E-07	2.5E-06	9.0E-24	3.1E-23	1.1E-19	2.1E-18
Ho-166	3.1E-03	4.0E-11	2.2E-11	5.6E-08	9.3E-07	1.5E-18	4.5E-18	1.8E-14	3.0E-13

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Er-166	NA	0.0E+00	0.0E+00	3.1E-10	8.3E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sm-167	---	0.0E+00	1.6E-12	3.5E-12	2.1E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Eu-167	---	2.2E-10	1.4E-09	6.9E-09	5.6E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Gd-167	---	3.7E-08	1.0E-07	1.1E-06	1.3E-05	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-167	6.0E-07	1.3E-07	2.1E-07	7.5E-06	1.1E-04	2.6E-11	2.2E-10	1.2E-08	1.8E-07
Dy-167	1.2E-05	7.5E-08	6.6E-08	6.4E-06	1.3E-04	7.3E-13	3.5E-12	5.2E-10	1.1E-08
Ho-167	3.5E-04	1.0E-09	5.2E-10	2.9E-07	8.2E-06	3.3E-16	9.1E-16	7.9E-13	2.3E-11
Er-167m	7.2E-08	0.0E+00	0.0E+00	1.6E-10	6.1E-09	0.0E+00	0.0E+00	2.1E-12	8.4E-11
Er-167	NA	1.1E-12	0.0E+00	1.1E-09	4.5E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tm-167	2.5E-02	0.0E+00	0.0E+00	0.0E+00	1.0E-11	0.0E+00	0.0E+00	0.0E+00	4.0E-19
Eu-168	NA	2.9E-12	2.8E-11	1.2E-10	8.9E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Gd-168	---	2.2E-09	9.4E-09	7.0E-08	7.2E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-168	2.5E-07	1.7E-08	4.0E-08	1.1E-06	1.5E-05	7.8E-12	9.6E-11	4.1E-09	5.9E-08
Dy-168	1.7E-05	3.6E-08	4.6E-08	2.8E-06	5.3E-05	2.5E-13	1.7E-12	1.6E-10	3.2E-09
Ho-168	5.7E-06	1.2E-09	8.5E-10	2.9E-07	7.3E-06	2.3E-14	9.2E-14	4.9E-11	1.3E-09
Er-168	---	6.8E-12	2.7E-12	4.3E-09	1.6E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tm-168	2.6E-01	0.0E+00	0.0E+00	1.6E-12	8.3E-11	0.0E+00	0.0E+00	5.9E-21	3.2E-19
Eu-169	---	0.0E+00	1.1E-12	2.3E-12	1.4E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Gd-169	---	1.2E-10	9.5E-10	3.3E-09	3.0E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] *The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).*

NA = Not applicable: no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Tb-169	---	4.1E-09	1.6E-08	1.8E-07	2.1E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dy-169	1.2E-06	1.7E-08	3.8E-08	9.7E-07	1.7E-05	1.6E-12	1.9E-11	7.5E-10	1.3E-08
Ho-169	8.9E-06	2.2E-09	2.8E-09	3.1E-07	6.8E-06	2.9E-14	1.9E-13	3.3E-11	7.6E-10
Er-169	2.6E-02	3.3E-11	2.3E-11	1.1E-08	3.5E-07	1.5E-19	5.4E-19	4.1E-16	1.4E-14
Tm-169	NA	0.0E+00	0.0E+00	1.5E-11	6.7E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Gd-170	---	2.7E-12	4.4E-11	8.1E-11	8.5E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-170	---	2.2E-10	1.7E-09	1.0E-08	1.5E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dy-170	---	3.7E-09	1.5E-08	1.8E-07	3.7E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-170m	1.4E-06	4.9E-10	1.2E-09	5.8E-08	1.6E-06	4.1E-14	5.3E-13	4.1E-11	1.2E-09
Ho-170	5.3E-06	4.9E-10	1.2E-09	5.8E-08	1.6E-06	1.1E-14	1.4E-13	1.0E-11	3.0E-10
Er-170	NA	6.4E-11	8.3E-11	1.4E-08	5.5E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tm-170	3.5E-01	0.0E+00	0.0E+00	4.5E-11	2.6E-09	0.0E+00	0.0E+00	1.2E-19	7.4E-18
Gd-171	---	0.0E+00	1.2E-12	2.4E-12	1.5E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Tb-171	---	2.9E-11	2.2E-10	1.1E-09	9.5E-09	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dy-171	---	1.1E-09	4.0E-09	4.4E-08	5.6E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-171	1.7E-06	1.1E-09	2.3E-09	8.9E-08	1.5E-06	7.3E-14	8.5E-13	5.1E-11	8.6E-10
Er-171	8.6E-04	1.6E-10	1.9E-10	2.3E-08	5.4E-07	2.1E-17	1.3E-16	2.5E-14	6.3E-13
Tm-171	1.9E+00	0.0E+00	0.0E+00	2.7E-10	9.0E-09	0.0E+00	0.0E+00	1.4E-19	4.7E-18
Yb-171	NA	0.0E+00	0.0E+00	0.0E+00	1.4E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = Not applicable; no half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-2 (Continued)
Fission Product Yields and Activity Fractions for Mixed-Fission Product Waste at the Time of Generation

Isotope	Half-Life (yr) [a]	Fission Yields (yield/100 fissions)				Fractional Abundance (activity basis)			
		U-235		Pu-239		U-235		Pu-239	
		Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Tb-172	---	1.1E-12	1.1E-11	4.1E-11	2.8E-10	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Dy-172	---	1.8E-10	7.7E-10	5.6E-09	5.7E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Ho-172	7.9E-07	3.7E-10	8.7E-10	2.4E-08	3.3E-07	5.3E-14	6.7E-13	2.9E-11	4.1E-10
Er-172	5.6E-03	2.2E-10	2.7E-10	1.9E-08	3.7E-07	4.5E-18	3.0E-17	3.3E-15	6.5E-14
Tm-172	7.3E-03	1.7E-12	1.1E-12	5.4E-10	1.5E-08	2.7E-20	9.6E-20	7.1E-17	2.0E-15
Yb-172	NA	0.0E+00	0.0E+00	1.9E-12	7.9E-11	0.0E+00	0.0E+00	0.0E+00	0.0E+00

[a] The primary source of radionuclide half-lives was KAPL (2002). Alternate sources include England and Rider (1994) and NNDC (2004).

NA = No half-life or fractional abundances are provided because the isotope is stable

--- = No half-life was found for the radionuclide; the isotope was not included in the fission product allocation

Table III-3
Radionuclide Activity Fractions for Mixed-Fission Product Waste as a Function of the Age of the Waste

Radionuclide	Activity Fractions							
	Waste Age = 1 yr				Waste Age = 2 yr			
	U-235 Fission		Pu-239 Fission		U-235 Fission		Pu-239 Fission	
	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Kr-85	5.6E-02	1.3E-02	3.3E-03	2.5E-03	1.5E-01	2.0E-02	6.2E-03	4.6E-03
Sr-89	2.1E-02	1.9E-03	2.8E-03	7.4E-04	4.0E-04	2.1E-05	3.7E-05	9.7E-06
Sr-90	6.3E-02	5.5E-02	1.2E-02	4.6E-03	1.7E-01	9.1E-02	2.5E-02	8.9E-03
Y-91	6.8E-04	6.8E-04	7.7E-04	4.9E-04	2.5E-05	1.5E-05	2.1E-05	1.3E-05
Nb-95	2.0E-05	1.6E-06	1.6E-05	4.4E-06	---	---	---	---
Zr-95	3.5E-01	7.7E-02	5.2E-02	3.1E-02	1.9E-02	2.5E-03	2.0E-03	1.2E-03
Ru-103	8.7E-06	7.0E-06	7.0E-05	5.8E-05	---	---	---	---
Ru-106	1.1E-05	2.1E-05	6.1E-01	5.8E-01	1.6E-05	1.7E-05	6.2E-01	5.8E-01
Cd-115m	3.9E-06	3.2E-06	---	1.6E-06	---	---	---	---
Sn-119m	1.5E-06	6.5E-06	7.3E-06	1.1E-05	1.8E-06	4.6E-06	6.2E-06	9.5E-06
Sn-121m	1.6E-05	8.8E-05	4.6E-05	7.4E-05	4.3E-05	1.4E-04	9.1E-05	1.4E-04
Sn-123	8.0E-03	7.5E-02	1.6E-02	2.4E-02	3.2E-03	1.8E-02	4.5E-03	6.7E-03
Sb-124	1.7E-05	7.6E-04	1.7E-05	2.1E-05	---	1.9E-05	---	---
Sb-125	1.9E-04	5.1E-04	7.0E-04	8.0E-04	4.2E-04	6.6E-04	1.1E-03	1.2E-03
Sn-126	4.8E-06	1.4E-05	2.8E-06	2.9E-06	1.4E-05	2.4E-05	5.6E-06	5.8E-06
Te-127m	---	---	2.2E-06	1.7E-06	---	---	---	---
Te-129m	2.0E-06	3.3E-06	1.1E-05	6.9E-06	---	---	---	---

--- = Indicates the radionuclide is not generated by the specified fission event or is present at a radionuclide activity fraction of less than 1.0×10^{-6} due to radioactive decay.

Table III-3 (Continued)
Radionuclide Activity Fractions for Mixed-Fission Product Waste as a Function of the Age of the Waste

Radionuclide	Activity Fractions							
	Waste Age = 1 yr				Waste Age = 2 yr			
	U-235 Fission		Pu-239 Fission		U-235 Fission		Pu-239 Fission	
	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Cs-137	4.9E-02	3.5E-01	7.3E-02	9.8E-02	1.3E-01	5.8E-01	1.4E-01	1.9E-01
Ce-141	---	7.2E-06	4.0E-06	3.5E-06	---	---	---	---
Ce-144	4.5E-01	4.2E-01	2.3E-01	2.6E-01	5.3E-01	2.9E-01	1.9E-01	2.1E-01
Pm-147	---	---	---	---	---	---	1.1E-06	
Sm-151	---	---	1.6E-06	1.8E-06	---	---	3.2E-06	3.5E-06
Eu-154	---	---	1.1E-05	1.5E-05	1.3E-06	---	2.1E-05	2.8E-05
Eu-155	1.2E-05	9.5E-06	1.3E-04	2.5E-04	2.9E-05	1.4E-05	2.3E-04	4.2E-04
Tb-160	---	---	3.6E-06	8.3E-06	---	---	---	---

Radionuclide	Activity Fractions							
	Waste Age = 5 yr				Waste Age = 10 yr			
	U-235 Fission		Pu-239 Fission		U-235 Fission		Pu-239 Fission	
	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Kr-85	2.7E-01	2.5E-02	2.0E-02	1.4E-02	2.6E-01	2.1E-02	2.5E-02	1.6E-02
Sr-89	---	---	---	---	---	---	---	---
Sr-90	3.6E-01	1.3E-01	8.8E-02	3.0E-02	4.2E-01	1.3E-01	1.4E-01	4.3E-02

--- = Indicates the radionuclide is not generated by the specified fission event or is present at a radionuclide activity fraction of less than $1.0x10^{-6}$ due to radioactive decay.

Table III-3 (Continued)
Radionuclide Activity Fractions for Mixed-Fission Product Waste as a Function of the Age of the Waste

Radionuclide	Activity Fractions							
	Waste Age = 5 yr				Waste Age = 10 yr			
	U-235 Fission		Pu-239 Fission		U-235 Fission		Pu-239 Fission	
	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Y-91	---	---	---	---	---	---	---	---
Nb-95	---	---	---	---	---	---	---	---
Zr-95	---	---	---	---	---	---	---	---
Ru-103	---	---	---	---	---	---	---	---
Ru-106	4.7E-06	3.4E-06	3.1E-01	2.7E-01	---	---	1.8E-02	1.5E-02
Cd-115m	---	---	---	---	---	---	---	---
Sn-119m	---	---	1.8E-06	2.5E-06	---	---	---	---
Sn-121m	9.3E-05	2.1E-04	3.4E-04	4.9E-04	1.1E-04	2.2E-04	5.4E-04	7.5E-04
Sn-123	2.0E-05	7.6E-05	4.9E-05	6.7E-05	---	---	---	---
Sb-124	---	---	---	---	---	---	---	---
Sb-125	4.5E-04	4.7E-04	2.0E-03	2.1E-03	1.7E-04	1.6E-04	1.0E-04	9.6E-04
Sn-126	3.1E-05	3.6E-05	2.2E-05	2.1E-05	4.0E-05	4.1E-05	3.8E-05	3.4E-05
Te-127m	---	---	---	---	---	---	---	---
Te-129m	---	---	---	---	---	---	---	---
Cs-137	2.8E-01	8.2E-01	5.2E-01	6.3E-01	3.3E-01	8.5E-01	8.2E-01	9.2E-01
Ce-141	---	---	---	---	---	---	---	---
Ce-144	8.3E-02	3.1E-02	5.2E-02	5.3E-02	1.3E-03	4.2E-04	1.1E-03	1.0E-03
Pm-147	---	---	2.0E-06	1.5E-06	---	---	---	---

--- = *Indicates the radionuclide is not generated by the specified fission event or is present at a radionuclide activity fraction of less than* 1.0×10^{-6} *due to radioactive decay.*

Table III-3 (Continued)
Radionuclide Activity Fractions for Mixed-Fission Product Waste as a Function of the Age of the Waste

Radionuclide	Activity Fractions							
	Waste Age = 5 yr				Waste Age = 10 yr			
	U-235 Fission		Pu-239 Fission		U-235 Fission		Pu-239 Fission	
	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons	Thermal Neutrons	Fast Neutrons
Sm-151	---	---	1.2E-05	1.2E-05	1.0E-06	---	2.1E-05	1.9E-05
Eu-154	2.4E-06	0.0E+00	6.4E-05	7.8E-05	2.1E-06	---	7.5E-05	8.6E-05
Eu-155	4.2E-05	1.3E-05	5.8E-04	9.7E-04	2.7E-05	7.6E-06	4.9E-04	7.7E-04
Tb-160	---	---	---	---	---	---	---	---

--- = Indicates the radionuclide is not generated by the specified fission event or is present at a radionuclide activity fraction of less than 1.0×10^{-6} due to radioactive decay.

--- = Indicates the radionuclide is not generated by the specified fission event or is present at a radionuclide activity fraction of less than 1.0×10^{-6} due to radioactive decay.

Lacking additional information, a definitive assessment of the proportion of the MFP waste that was generated as a result of Pu-239 and U-235 fission events is not possible. Consequently, it was assumed that 15 percent of the waste was generated by Pu-239 fissions, with the remainder coming from U-235 fission events. All fission events were assumed to result from interactions with thermal neutrons. While some fission products will form as a result of interactions with fast neutrons, the majority will be generated by thermal fission.

It is virtually impossible to predict the time lapse between the generation of the fission-product waste and the characterization of the material for disposal for each of the numerous packages of waste that were shipped to MDA G. Consequently, the radionuclides present in the MFP waste were identified based on the simplified assumption that 2 years had elapsed between waste generation and disposal. Based on this assumption, the radionuclide activity fractions listed in Table III-3 for a waste age of 2 years were used to allocate the MFP activity.

III.3 Mixed-Activation Product Waste

Approximately 2.0×10^4 Ci of MAP waste were disposed of at MDA G from 1971–1996. Waste shipped from TA-48 accounted for 63 percent of the total activity and waste shipped from TA-53 accounted for another 34 percent. A large portion of the waste shipped by TA-48 originated at TA-53. All of the MAP waste shipped for disposal was LLW.

The MAP waste was allocated to specific radionuclides using information collected for the 1997 performance assessment and composite analysis (Hollis et al., 1997). Conversations with TA-53 staff indicated that the Los Alamos Meson Physics Facility at TA-53 (now referred to as the Los Alamos Neutron Science Center) generated three activated waste streams: trash, beam-line inserts, and targets (Hollis et al., 1997, Appendix 2f). Similar materials — such as steel, aluminum, and graphite — may occur in all three waste streams. The radionuclide abundances in the trash waste stream were established and these abundances were assumed to apply to all of the MAP waste that has been shipped for disposal.

The radionuclide abundances for the MAP waste are provided in Table III-4 in terms of mass fractions. Corresponding activity fractions were calculated by multiplying the mass fractions by the radionuclides' specific activities and normalizing these products by the sum of these activities. Many of the radionuclides included in the MAP waste have very short half-lives. Consequently, the radionuclide abundances in the waste will change significantly as the age of the waste increases and radioactive decay occurs. It was assumed that the age of the waste when it was shipped for disposal and the age of the material used to establish the radiological profile shown in Table III-4 were the same.

Table III-4
Radionuclide Mass and Activity Fractions for Mixed-Activation Product Waste

Radionuclide	Mass Fraction	Activity Fraction
Be-7	3.0E-02	7.0E-01
Na-22	1.0E-01	4.1E-02
Mn-54	1.8E-01	9.2E-02
Co-57	1.2E-01	6.7E-02
Co-60	4.4E-01	3.3E-02
Zn-65	1.3E-01	7.1E-02

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